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Volume 19, Number 13, July 15, 1965

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Volume 19, Number 13 July 15, 1965

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 25071.

24226 (ORNL-P-1111) HYBRID RESISTANCE TO PARENTAL HEMATOPOIETIC CELL GRAFTS: IMPLICATIONS FOR BONE MARROW CHIMERAS. Gustavo Cudkowicz (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 34p. (CONF-717-19). Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From CNRS Meeting on Graft of Allogenic Hematopoietic Cells, Paris, Sept. 1964.

F_1 hybrid mice that are heterozygous at the D region of the H-2 locus do not support optimal growth of transplanted parental marrow cells when the donor is homozygous for the H-2^b allele, although they fully support the growth of parental skin grafts. Resistance to grafted parental marrow, which is due to a single noncodominant gene, can be overriden either by increasing the number of grafted donor marrow cells to several times the number sufficient to repopulate the hematopoietic system of nonresistant irradiated recipients, or by increasing the radiation exposure of the resistant mice. The strength of the hybrid resistance, as measured by these two parameters, is of the same order of magnitude as the resistance to grafted marrow found in some H-2 incompatible allogenic donor-host combinations. Once the hybrid resistance is overridden by relatively large marrow inocula, the long-term persistence of these parental grafts is decided by independent factor(s) not associated with H-2, as revealed by studies of appropriate segregating mouse progeny. Transplantation of marrow of spleen cells from resistant F_1 hybrid donors into heavily irradiated isogenic mice and into parental strain mice carrying an H-2 allele other than H-2^b results in adoptive transfer of hybrid resistance. On the other hand, no hybrid resistance is transferred, nor does detectable graft-versus-host reaction occur in parental strain recipients homozygous for H-2^b given F_1 hematopoietic cells. Presumably, the latter cells become specifically unresponsive to parental isoantigen(s) associated with H-2^b when they are infused into H-2^b mice. The findings presented here indicate that marrow transplantation experiments are not complicated by parent-F_1 hybrid incompatibility to a greater extent than by histoincompatibilities due to the codominant H genes. (auth)

24227 (JPRS-29452) SOVIET ICHTHYOLOGICAL RESEARCH. Translated from Vopr. Ikhtiol., 4: 624-31; 644-57; 664-78; 716-35; 769-78(1964). 105p. (TT-65-30658) $4.00(CFSTI).

A separate abstract was prepared on one article. Other articles discuss various phases of Soviet ichthyological research. (C.H.)

For an abstract of the individual paper see: 24263.

24228 CONGENITAL ANOMALIES OF TEETH IN JAPANESE CHILDREN. Jerry D. Niswander and Chokudo Sujaku (National Inst. of Dental Research, Bethesda, Md. and Kurume Univ., Japan). Am. J. Phys. Anthropol., 21: 569-74(Dec. 1963).

A radiological survey of Nagasaki children for supernumerary, congenitally missing, and certain related anomalies of teeth is reported. Sibship data were utilized in an attempt to establish a simple mode of transmission for supernumerary teeth. This study was part of a survey of child health conducted at the Atomic Bomb Casualty Commission in Hiroshima and Nagasaki. All children were five to 12 yr of age, the average being 8.75 years. None of the parents of these children received significant radiation exposure from the atomic bomb. The primary purpose of the Child Health Survey was to evaluate the effects of inbreeding on mortality and morbidity in the prereproductive years. Accordingly, about one-half of the children were offspring of biologically related parents (second cousins or closer). Frequencies of supernumerary and/or congenitally missing teeth showed a highly significant difference between sexes. Supernumerary teeth occurred more frequently in males, whereas females had more missing teeth. The data for supernumerary teeth are compatible with the hypothesis of an autosomal recessive gene with decreased penetrance in the female and a frequency of about 0.24. An alternative mode of transmission considered is that of a sex-linked recessive. To support this hypothesis, 13 fathers of affected females were examined. X rays revealed one to be affected while the other 12 showed no evidence of the trait. Since all fathers should be affected under this hypothesis, sex linkage was eliminated from consideration. Similarly, this deficiency of affected fathers provides some evidence against an autosomal dominant trait. Since the data offer little support for any simple Mendelian mode of transmission with the possible exception of autosomal recessive, it is likely that more complex mechanisms involving multiple genes, environmental factors, or indirect genetic influences provide the correct explanation. The supernumerary teeth encountered were confined almost exclusively to the upper anterior region. (BBB)

24229 CHROMOSOME BREAKAGES IN FOUR CHRONIC MYELOID LEUKEMIA PATIENTS. Sajiro Makino and Akio A. Awa (Hokkaido Univ., Sapporo). Hereditas, 52: 253-64(1965).

Chromosome constitutions were investigated in 4 patients with chronic myelocytic leukemia, 2 adults and 2 children of both sexes. Three patients possessed consistently the Ph^1 chromosome in cultured blood cells and also in directly prepared bone marrow specimens. All cases showed chromosome breakages in certain percentage of cells from cultured blood samples, due possibly to x-ray treatment or advanced chemotherapy. The Ph^1 chromosome was not observed in cultured cells of the last blood sample from case 3 in a complete remission, while it was still detected in directly prepared marrow specimen taken at the same time. One patient showed no Ph^1 chromosome at any stage, while various chromosome breakages including structural changes

of chromosomes were observed in both bone marrow and cultured blood cells, before and after chemotherapy. Possible suggestion was made that such anomalies might have developed in association with leukemic changes in the leukopoietic tissue of the patient. (auth)

24230 LEUKEMIA IN CHILDREN: INCIDENCE, CLINICAL MANIFESTATIONS, AND SURVIVAL IN AN UNSELECTED SERIES. S. Spence Meighan (Good Samaritan Hospital, Portland, Ore.). J. Am. Med. Assoc., 190: 578-82(Nov. 16, 1964).

A total of 258 children in Oregon had leukemia during 1950 to 1961. The mean annual incidence of leukemia in children in Oregon was 4.53 per 100,000. In the entire United States in 1962 the mortality rate of leukemia in children was 3.6 per 100,000. The yearly incidence of leukemia in children in Oregon showed no significant change, and no evidence of increasing incidence was demonstrated in the period under study. The absence of change is in accord with the findings of others who have suggested that the major part of the reported increase in the incidence of leukemia has occurred in the adult population. There was no significant variation in the incidence of the disease by the month of onset of symptoms, a finding that did not support the previously reported increased incidence of acute lymphocytic leukemia in the summer season. The distribution of the children by age showed a peak of incidence at three years. The same peak was observed in the United Kingdom, but it did not occur among Japanese children nor nonwhite American children. Genetic factors in leukemogenesis are discussed. (BBB)

24231 NATURAL AND RADIATION CARCINOGENESIS IN MAN. II. NATURAL LEUKAEMOGENESIS: INITIATION. P. R. J. Burch (Medical Research Council, [Leeds, Eng.] and Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. B, 162: 240-62(Apr. 13, 1965).

A mathematical model of the initiation-phase of human carcinogenesis is applied to the interpretation of spontaneous or natural leukemogenesis. Extensive use is made of mortality statistics and of familial, genetic, cytogenetic, and epidemiological studies. It is found that the germ-cell mutation-frequency for leukemogenic genes (expressed in terms of: leukemogenic mutations, per gene at risk, per cell at risk, per year) is, within the limits of computational error, also applicable to somatic cells throughout the entire life span. This value approximates to the upper limit of the normal range of germ-cell mutation-frequencies observed for dominant autosomal and sex-linked loci in man. The initiation of prezygotic leukemias in adults appears generally to require a cell with one inherited specific gene or chromosomal-mutation, and three specific somatic mutations. In postzygotic leukemias increasing from about 1% of the natural incidence at 20 years, to about 7% at 70 years, all four leukemogenic mutations should be accumulated in one (or more) somatic cells. In chronic lymphatic leukemias (pre-, or post-zygotic), cells with the appropriate three leukemogenic mutations probably exhibit selective proliferation; this should be characteristic of many malignancies in adults, especially those of epithelial tissue. When premalignant selective proliferation is present, multi-focal tumor origin may be anticipated. The initiation of the majority of leukemias in childhood and adolescence probably requires at least one cell with one inherited mutation and two somatic mutations: a condition of stress is then necessary for malignant development. This stress may be provided by a viral or bacterial infection (for which there is independent evidence). Occasionally, but especially with parental consanguinity, recessive inheritance of childhood malignancies is observed and the etiology in such cases involves a cell with two inherited (homologous) mutations and two specific somatic mutations; no stress factor is then necessary to complete the initiation-phase. The theory accounts for many qualitative and quantitative details of the familial and epidemiological evidence, and it illustrates the advantages of a mathematical approach. (auth)

24232 THE EFFECTS OF IRRADIATION ON ENDOCRINE CELLS. V. A COMPARISON BETWEEN THE EFFECTS OF INANITION AND IRRADIATION ON ANDROGEN PRODUCTION BY MURINE TESTICULAR TISSUE. David L. Berliner and LeGrande C. Ellis (Univ. of Utah, Salt Lake City). Radiation Res., 24: 572-8(Apr. 1965).

Male rats (Holtzman strain) were individually fed 7.5 g of laboratory chow daily for 20 days. Control animals were fed the same ration, and water was given ad libitum to both groups of rats. Treatment was initiated when the animals were 15 weeks of age. Testicular tissue from both groups of animals was incubated with 5-pregnenolone-7α-^{3}H and progesterone-4-^{14}C. Incubations from both groups of animals were made with and without added cofactors. After 20 days of treatment, body weights, testicular weights, and seminal vesicle weights were diminished. Also, the in vitro biosynthesis of androgens was markedly diminished as a result of this treatment. The effects of inanition on androgen biosynthesis differed from those observed previously for irradiation in that they were not reversed by the addition of a NADPH-G-S. The reduction in androgen biosynthesis observed was attributed to a lack of enzymes required for the biotransformation of 5-pregnenolone and progesterone into androgens. Evidence was observed for a diminished desmolase activity (side-chain splitting). The diminished enzyme activity of the testis was attributed to a lack of gonodotrophins. Thus, it would appear that inanition does diminish androgen production by the testis, but the effect differs from that observed for irradiation. (auth)

24233 VASCULAR ROENTGENOLOGY, ARTERIOGRAPHY, PHLEBOGRAPHY, LYMPHOGRAPHY. Robert A. Schobinger, and Francis F. Ruzicka, eds. New York, The Macmillan Company, 1964. 757p.

Information is included on: contrast media; untoward effects of angiography, anesthesia for angiography; venipuncture and vascular cutdown; insertion of catheter by cannula replacement; principles of percutaneous selective angiography; transosseous phlebography; selective cineangiocardiography; angiography in children; equipment; and gross anatomy, roentgen anatomy, techniques, indications, contraindications, and limitations in angiocardiography, arteriography, phlebography, and lymphography. (P.C.H.)

24234 PROGRESS IN HEMATOLOGY. VOLUME IV. Carl V. Moore and Elmer B. Brown, eds. New York, Grune and Stratton, 1964. 316p.

Information is included on: heme synthesis in erythroid cells; methemoglobinemia in man, erythropoietin; chemistry of the ABH blood group substances; hematology of lead poisoning; chloramphenicol toxicity; myeloma proteins and macroglobulins; advances in acute leukemia; Von Willebrand's disease; and platelet and leukocyte isoantigens and their antibodies. (P.C.H.)

24235 BIOLOGICAL EFFECTS OF MAGNETIC FIELDS. Madeleine F. Barnothy, ed. New York, Plenum Press, 1964. 331p. $16.00.

Information is included on: theory of biomagnetism; effects of strong magnetic fields of specimens in vivo; effects of strong magnetic fields on specimens in vitro; and effects of very weak magnetic fields. An extensive bibliography for each of the four sections is included. (P.C.H.)

Ecology

Refer also to abstract 24759.

24236 (COO-1296-1) THE REVEGETATION AT THE NEW MEXICO ATOMIC BOMB CRATER. David B. Dunn and David L. Spellman (Missouri Univ., Columbia). [nd]. Contract [AT(11-1)-1296]. 47p. Dep.(mn); $2.00(cy), 1 (mn) CFSTI.

Data collected during 1964 are presented from a 3-year survey of the vegetation of the New Mexico Atomic Bomb Crater resulting from the explosion of the atomic bomb during Trinity Operation in 1945. The objective of the study was to determine the extent to which vegetation has returned to normal condition during the 20-year period. Early phases of revegetation of the site were first studied in 1947 when radial, belt-transects of the area were estab-

lished. The geology and climate of the area are reviewed and methods used for the vegetation survey are described. Data are tabulated on the distribution and number of all plant species in one transect of each community. Variations between species found in 1964 and 1963 are discussed. Conditions of each plant community are illustrated photographically. It was concluded that the area is still a long way from returning to its climax or subclimax. It was also concluded that the distributional pattern is related to water availability, soil conditions, and seasonal timing of climatic varients rather than radiation. (C.H.)

24237 (TID-3910(Suppl.3)) TERRESTRIAL AND FRESHWATER RADIOECOLOGY. A Selected Bibliography—Supplement 3. Alfred W. Klement, Jr., and Vincent Schultz (Division of Biology and Medicine (AEC), Washington, D. C.). Feb. 1965. 119p. Dep.; $2.50(cy), 2(mn) CFSTI.

A list is presented of 1207 publications in the field of radioecology, including the biological aspects of radioactive fallout, waste disposal, terrestrial radioecology, and freshwater radioecology. An attempt was made to reference publications related to the field or laboratory studies of wild species of plants and animals with respect to radiation effects or metabolic studies involving radionuclides. Complete information concerning reference sources and brief content notes are included. (C.H.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 24474, 24720, 24723, 24760, and 25780.

24238 (AWRE-O-4/65) CHELATING AGENTS. PART 2. RADIOELEMENT REMOVAL AND THE STRONTIUM-90 PROBLEM. J. H. Grimes, A. J. Huggard, and K. T. B. Scott (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1965. Dep(mn); $1.20(BIS), 6s. Od. (HMSO).

The radioelements which at present constitute hazards to humans are considered with respect to their behavior in the body. Theoretical considerations for their removal from blood and from bone are presented, and suggestions are made for the properties of a suitable chelating agent. Chelation with the alkaline earth metals is discussed and the possibilities of obtaining a strontium-preferring chelating agent are outlined. (auth)

24239 (BNL-8031) CARRIER AND OVERLOADING EFFECTS ON THE METABOLISM OF DL-TRYPTOPHAN-7a-C^{14}. L. V. Hankes and Max Schmaeler (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract [AT(30-2)-Gen-16]. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Previous work with human subjects demonstrated a relationship between the amount of carrier added to a tracer dose of DL-tryptophan-2-^{14}C and the per cent of the ^{14}C expired as $^{14}CO_2$. As the amount of carrier added to a dose of 100 μC of ^{14}C was increased from zero to 2 gms, the percent ^{14}C expired as $^{14}CO_2$ in 24 hours increased from 4.5 to 25%. The data suggested that given quantities of tryptophan were converted into proteins and enzymes, but that the excess was metabolized to CO_2 via the kynurenine-3-hydroxyanthranilic acid-acetate pathway or some other pathway to be elucidated. The metabolism of DL-tryptophan-7a-^{14}C as affected by doses of L-tryptophan, DL-kynurenine, 3-hydroxyanthranilic acid (3-OHAA), and quinolinic acid (QA), which would be equivalent to a 2 gm overload of L-tryptophan in a 70 kg man was investigated in rats. Preliminary results indicate that carrier levels of doses of ^{14}C-labeled compounds play an important role in metabolic patterns. (C.H.)

24240 (BNL-8053) EFFECT OF OVARIAN HORMONES ON DURATION OF DNA SYNTHESIS IN CELLS OF THE C3H MOUSE MAMMARY GLAND. Francesco Bresciani (Brookhaven National Lab., Upton, N. Y. and Naples Univ. (Italy). Istituto di Patologie Generale). [1963]. Contract [AT(30-2)-Gen-16]. 40p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

High-resolution autoradiography combined with specific labeling of DNA after the injection of ^{3}H-thymidine or ^{14}C-thymidine was used to study the relation between hormones, especially 17-β-estradiol and progesterone, on the growth and development of the mammary gland of mice in early puberty (10 weeks) and in adult virgin condition (6 months old). Qualitative observations are presented on the topography of DNA synthesis in the mammary tree, which together with measurements of time of availability of the radioactive DNA label to mammary cells after a single intraperitoneal injection, were used to determine the duration of DNA synthesis in normal mice and ovariectomized mice treated with 17-β-estradiol or progesterone, or both hormones combined. Two possible hypotheses for the stimulatory effect of the hormones are proposed. It was concluded that in cells of the mammary gland DNA synthesis is not an unadjustable process of the generative cycle, but varies with the proliferative rate. (C.H.)

24241 (COO-1170-3) ORGAN DISTRIBUTION FOLLOWING AN INTRAPULMONARY INJECTION OF RARE-EARTH COMPOUNDS. Fred C. Davison, William O. Reece, and Richard B. Talbot (Iowa State Univ. of Science and Tech., Ames. Inst. for Atomic Research and Iowa State Univ. of Science and Tech., Ames. Veterinary Medical Research Inst.). Apr. 1965. Contract AT(11-1)-1170. 19p. Dep.; $1.00(cy), 1(mn)CFSTI.

Distribution studies in guinea pigs and rats, following intrapulmonary injections of stable rare earth citrates and oxalates, showed a significant lung burden still present 120 days after injection. Data are presented that demonstrate translocation to the femur, liver, kidney, spleen, heart, adrenals, gonads, and brain. (auth)

24242 (NP-14901) THE UPTAKE, ACCUMULATION AND EXCHANGE OF RADIOISOTOPES BY OPEN SEA PHYTOPLANKTON. Final Report. E. F. Corcoran (Miami Univ., Fla. Marine Lab.). Dec. 1963. 32p. (ML-63611). Dep.(mn)

A 2.5 year study was made of the uptake, accumulation and exchange of the radioisotope $^{90}Sr-^{90}Y$, ^{90}Y, ^{90}Sr, and $^{137}Cs-^{137}Ba$ by tropical oceanic phytoplankton and many of the parameters which influence these phenomena. All the organisms used in these studies are representative of the open sea environment. While in the early work the cultures contained some bacteria, their affect was minimized through selected conditions. In all later research, the cultures were free of bacteria. All experiments were conducted with healthy, actively growing organisms usually during their logarithmic growth phase. The results of this study show that all the organisms tested were capable of removing the radionuclides from the sea water. In addition, not only were they able to remove nuclides, but they were also capable of selecting the desired nuclide. For example, K. rotundata selected only strontium while G. simplex took up the yttrium when exposed to $^{90}Sr-^{90}Y$ solution. The ability to accumulate and concentrate the Cs and Sr from the sea water medium was primarily through absorption with adsorption playing only a very minor role. Hence, when radioactive cells were placed in fresh media the loss of radioactivity to the medium was small and a steady state was established very quickly, usually within 24 hours. Since absorption seems to be primarily responsible for the accumulation of Sr and Cs by the phytoplankton it is of the utmost importance that more is learned, of the basic mechanisms involved. Before an ion can be absorbed, transport across the cell membrane must take place. Several mechanisms have been proposed for such a penetration but each involves an expenditure of energy, either directly or indirectly. The energy required for active transport which is linked with metabolic reactions is unknown. It is very probable that each ion requires a specific organic compound to act as a carrier for membrane penetration. Since phytoplankton serves as food for other organisms, determination of the site of the accumulation of the radioisotope will help predict its accumulation at other trophic levels but extrapolation of these results to the open sea environ-

ment should not be done without first making a thorough in situ investigation. (C.H.)

24243 (JPRS-29457) DETERMINATION OF THE RESERVE OF ASSIMILABLE PHOSPHATES IN SOILS USING P^{32} PHOSPHORUS ISOTOPE. K. I. Imangaziev and M. Kh. Agishev. Translated from Vest. Akad. Nauk Daz. SSR, No. 12, 15-24(1964). 15p. (TT-65-30663) $1.00 (CFSTI).

Determination of the reserve of assimilable soil phosphates and the coefficient of their utilization by plants with the use of ^{32}P enabled us to establish with the highest accuracy the actual quantity of assimilable phosphates, as compared to other methods. The mean content of this form of P_2O_5 in the cultivable layer of chestnut and meadow-sierozemic soils amounts to 6 mg, taken without fertilizers, and 11 mg, when fertilizers had been used, per 100 grams of soil, which converted to one hectare is equal to 180 and 330 kg. Of these amounts of P_2O_5 about 20 to 25% is used by the plants, the remainder stays in the soils. Of all the crops tested, the greatest quantity of soil phosphates is extracted by buckwheat and tomatoes, and the lowest quantity, by spring wheat. Upon systematic introduction of phosphorus fertilizers, an appreciable amount of assimilable phosphates accumulates in the soil, which are well utilized by the subsequent crops in the field rotation of crops. The reserve of assimilable phosphates in dark-chestnut soil is higher than in light-chestnut and meadow-sierozemic soils, but their availability, conversely, is higher in the latter two soil types. In variations of station experiments with and without introduction of phosphorus fertilizers, assimilation of soil phosphates by plants proceeds differently. Upon the introduction of phosphorus fertilizers the coefficient of utilization of soil phosphates is appreciably reduced. The reserves of assimilable phosphates, determined by the greenhouse and radiochemical methods, are relatively similar. (auth)

24244 PROTEIN SYNTHESIS DURING PHOTOSYNTHESIS. J. A. Bassham, Bronislawa Morawiecka, and Martha Kirk (Univ. of California, Berkeley). Biochim. Biophys. Acta, 90: 542-52(Sept. 4, 1964). (UCRL-11141)

Kinetic studies were performed on the appearance of ^{14}C in free amino acid pools and in the amino acid moieties of protein in Chlorella pyrenoidosa during steady-state photosynthesis with $^{14}CO_2$. At the same time, the total concentrations of free and bound amino acids was determined and this permitted the calculation of the specific radioactivity of the free and bound pools of certain primary amino acids. Comparison of the specific activities of the free amino acid pools with the rate of ^{14}C-labeling of the corresponding pools of bound amino acids showed that there is a direct kinetic precursor-product relationship between the actively-turning-over pools of free amino acids and the bound amino acids in the protein. In the case of certain amino acids, notably glycine, the actively-turning-over pool of free amino acid was very small, leading to saturation when the average specific activity of the entire free amino acid pool of glycine was only 0.015. The total rate of labeling with ^{14}C of the bound amino acids in protein appears to account for only a fraction of the steady-state rate of labeling of the free amino acid pools. Explanations are offered for the apparent discrepancy. (auth)

24245 THE RENAL CLEARANCE OF SODIUM PENTABORATE IN MICE AND MEN. Lee E. Farr and T. Konikowski (Univ. of Texas, Houston). Clin. Chem., 9: 717-26 (Dec. 1963).

In studies exploring the effectiveness of the interaction of thermal neutrons and a target atom, ^{10}B, to control malignant tumors, data were obtained on the renal distribution and excretion of the inorganic B salts used, namely borax, or sodium tetraborate ($Na_2B_4O_7 \cdot 10H_2O$), and sodium pentaborate ($Na_2B_{10}O_{16} \cdot 10H_2O$). From data on B excretion and a knowledge of the blood B concentration at given times after injection, it was possible to calculate a renal B clearance. The renal blood clearance of sodium pentaborate was observed in eight patients undergoing neutron capture therapy for intracranial malignant tumors and was found to average 39.1 ml/min/1.73 m^2 surface area. The renal blood clearance was calculated for mice receiving sodium pentaborate intravenously in dosages of 25 $\mu g/g$ body weight and 100 $\mu g/g$, calculated as B. The average clearance for the mice receiving the larger dose was 0.207 ml/min for a 21-g mouse. The average clearance for the mice receiving the smaller dose was 0.192 ml/min/21-g mouse. For the mouse, clearance calculated for a surface area of 1.73 m^2 as was used in man, averages 40 ml/min. No toxic effects on renal function were observed in mice at the higher dosage. Comparison of the clearances observed in the mouse and in man suggests that a 35 mg/kg dose of B in man would not be toxic. From general clinical observations it is suggested that a dose of this size is quite safe, and only a minimum of toxic manifestation will ensue. (BBB)

24246 METABOLISM OF SOME FISSION PRODUCTS BY FARM ANIMALS. F. W. Lengemann and C. L. Comar (Atomic Energy Commission, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 92-115 (1964).

For a fission product to be of significance in the food chain of man it must be produced in a large amount, have a half-life that gives it time to move through the food chain, and be capable of being absorbed into the body. The movement of fission products through farm animals and transfer to man by the consumption of meat, milk, or eggs is discussed. Emphasis is placed on the metabolism of ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr by farm animals and the routes by which they may be transferred to man. (C.H.)

24247 METABOLISM OF RADIONUCLIDES IN MAN. J. F. Loutit (Medical Research Council, Harwell, Berks, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 116-22(1964).

The metabolism of ^{131}I, ^{90}Sr, and ^{137}Cs in man is reviewed with emphasis on the contribution of these fallout fission products to the radiation exposure of man. (C.H.)

24248 INFLUENCE OF DIETARY COMPOSITION ON RADIONUCLIDE INTAKE. L. J. Middleton (Agricultural Research Council Radiobiological Lab., Berks, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 123-34 (1964).

Data from food balance sheets and dietary surveys are used to estimate the internal radiation exposure of the general population from the consumption of foods contaminated with ^{137}Cs and ^{90}Sr. The relation of Ca in the diet to ^{90}Sr metabolism, sources of ^{90}Sr, and ^{137}Cs in diet, and methods used to estimate the content of ^{90}Sr and ^{137}Cs in individual food items and in the total diet are discussed. (C.H.)

24249 THE LOCALIZATION OF RADIOACTIVE CALCIUM (^{45}Ca) HYDROXIDE OVER EXPOSED PULPS IN RHESUS MONKEY TEETH: A PRELIMINARY REPORT. Marvin M. Stark, Howard M. Myers, Merle Morris, and Richard Gardner (Univ. of California, San Francisco). J. Oral Therap. Pharmacol., 1: 290-7(Nov. 1964).

A new use for radiocalcium is described in which ^{45}Ca was employed to study the role of calcium hydroxide as a pulp-dressing agent over exposed pulps to elicit the formation of calcified material. Clinical and experimental evidence indicates that $Ca(OH)_2$ placed over an exposed pulp causes the production of secondary dentin at the exposure site, and that it does this faster than other known pulp-dressing agents. This investigation was undertaken to determine whether the ^{45}Ca migrates to a new site and enters into secondary dentin formation. Cavities were produced in the teeth of young adult Rhesus monkeys. One mC of ^{45}Ca in 1.0 ml of solution was added to 5.0 ml of $Ca(OH)_2$ paste, which was mixed in a shaker for 5 min. This was applied to the cavity, followed by the application of a layer of zinc oxide and eugenol, zinc oxyphosphate cement, and finally an amalgam restoration. The $^{45}Ca(OH)_2$ was in contact with the pulpal tissue an average of 4.5 months. Teeth were extracted after this period and immediately placed in 10% neutral formalin for five days. The ^{45}Ca-treated teeth were mounted in Bio-Plastic and sectioned to a thickness of 170 μ. The sections were mounted serially on paper, and then placed against the emulsion side of a sheet of film. Eight weeks were allowed for exposure of the film. These autoradiographs demonstrated that the area of placement of the original radioactive material was confined, in large ex-

tent, to the cavity preparation. Radioautographs also demonstrated that ^{45}Ca migrated from its point of deposition in the cavity preparation and produced scattered areas of radioactivity in the pulp in 25% of the sections studied. This substantiates the hypothesis that Ca in the $Ca(OH)_2$ enters into the formation of reparative dentin. (BBB)

24250 THE ASSESSMENT OF SOME RADIOTOXICOLOGICAL CHARACTERISTICS OF P^{32}. V. P. Pugachevskii and I. A. Likhtarev (Kiev Scientific-Research Inst. of Occupational Diseases, USSR). Med. Radiol., 10: No. 2, 17-22(Feb. 1965). (In Russian)

In single and multiple peroral administration of radiophosphorus to albino rats (106), the author investigated the nature of isotope distribution in different organs and tissues. The feasibility of utilizing data of single administration for calculating the quantity of radiophosphorus accumulated by tissues in its multifold introduction is discussed. The results of these experiments show that the employment of data of single ^{32}P administration for assessing the concentration, the dose value, and absorbed doses may result in augmented values of the indices referred to. The data derived help to simplify significantly the dose calculation. The mean error as the result of such simplifications would be no more than 36%, this meeting the requirements of a whole number of practical tasks of dosimetry. (tr-auth)

24251 ACCELERATED EXCRETION OF RADIOIODINE FROM THE ORGANISM. Yu. F. Koval and L. I. Evlanova (Kirov Military Medical Academy, Leningrad). Med. Radiol., 10: No. 2, 41-4(Feb. 1965). (In Russian)

The authors studied the accelerated excretion of radioiodine with the urine in mice under the influence of sodium iodate, ammonium rhodanate, sodium nitrate, sodium chlorate, potassium perchlorate, and mercazole. In osmotic diuresis in rabbits, caused with the aid of glucose, the urinary excretion of radioiodine and stable iodine was investigated. It was found that the greatest acceleration of radioiodine excretion was observed in mice under the influence of potassium perchlorate, to a lesser degree under the effect of ammonium rhodanate, sodium iodate, and mercazole. In osmotic diuresis in rabbits, the urinary excretion of radioiodine reached 10%/hour in respect to the introduced quantity, whereas in the control group it was below 1% on the average. For the elimination of radioiodine from the organism it is expedient to use potassium perchlorate, mercazole, or potassium iodate in conjunction with osmotic diuretics. (tr-auth)

24252 THE COMPARATIVE SENSITIVITY OF GENETICALLY DIFFERENT MOUSE STRAINS TO RADIOSTRONTIUM. V. L. Shvedov. Med. Radiol., 10: No. 2, 48-51 (Feb. 1965). (In Russian)

The sensitivity of genetically different mouse strains to the action of ^{90}Sr was investigated. Male mice of A strain proved to be the most sensitive to this isotope. In a progressing resistance order were male mice of strains C_{57}-black, BAJIB and CC_{57}-brown. Female animals of the referred to strains follow the same order but on an elevated level. The difference of $LD_{50/30}$ between males and females of the same strain ranged from 21.6 per cent (CC_{57}) to 67.5 per cent (A). (tr-auth)

24253 MEASUREMENT OF THE SOLUBILITY OF XENON-133 IN BLOOD AND HUMAN BRAIN. W. H. Isbister, P. F. Schofield, and H. B. Torrance (Manchester Royal Infirmary, Eng.). Phys. Med. Biol., 10: 243-50(Apr. 1965).

The partition coefficient of ^{133}Xe in blood and brain was determined directly in human tissues at varying levels of hematocrit. The mean partition coefficient for ^{133}Xe between white matter and blood was 0.171 and the mean partition coefficient between grey matter and blood was 0.107 at hematocrits of 50%. A statistical comparison was made between these results and those of others. (auth)

24254 THE INFLUENCE OF THE STRONTIUM/CALCIUM RATIO OF THE NUTRIENT SOLUTION ON THE TRANSLOCATION AND CHEMICAL FORMS OF STRONTIUM AND CALCIUM IN PISUM SATIVUM. C. Myttenaere (Centre d'Etudes Nucleaires, Mol, Belg.). Radiation Botany, 5: 143-51(May 1965).

The effect of the strontium/calcium ratio of the nutrient solution was studied under controlled conditions in Pisum sativum. The nutrient solutions varied in their Sr/Ca ratio whereas the sum total of strontium and calcium was maintained at 5-m-equiv./l. Translocation rates, concentration factors as well as the chemical forms of strontium and calcium were studied. The results indicate a different distribution of strontium and of calcium in the shoot and in the roots depending upon the Sr/Ca ratio of the nutrient solution. For a very low ratio (as occurs in soil, taking into account the greater retention of strontium than of calcium by the substrate and the amounts generally present) the calcium content of the shoot increases more rapidly than that of strontium. In this case the concentration factor for strontium is greater in the roots than in the shoot. When the Sr/Ca ratio increases the reverse is eventually obtained. A low Sr/Ca ratio results also in a different chemical distribution of these elements. The lower the concentration of strontium in the nutrient solution the greater is the fraction soluble in HCl 2N. The distributions of calcium and strontium are clearly different for a lower Sr/Ca ratio. (auth)

24255 DIFFERENCES IN KINETICS OF P-32 REMOVAL FROM THE OVARIES IN SINGLE- AND REPEATED ISOTOPE DOSES TO THE ORGANISM. M. A. Khvoinitskaya, L. A. Dobrovolskii, and I. A. Likhtarev. Radiobiologiya, 5: 310-11(1965). (In Russian)

White rats were given ^{32}P solution subcutaneously, one group 2 μC per animal in a single injection and the other 2 μC daily for 1.5 years. In the single-dose group the ovarian concentration decreased linearly with time. Use of these data to calculate the concentration for multiple-dose conditions gave values 200% higher than those found experimentally. (IIC-M.G.)

24256 THE ACCUMULATION OF RADIO-CAESIUM BY MARINE AND BRACKISH WATER INVERTEBRATES. G. W. Bryan (Marine Biological Association of the United Kingdom, Plymouth, Eng.). p.85-93 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Laboratory experiments on the absorption by marine invertebrates of ^{137}Co dissolved in sea water are discussed in relation to the K concentration of the animal, body size, temperature, and the inactive Cs and K concentrations of sea water. The smaller amount of information on the absorption by marine invertebrates of radiocesium from food is then considered, and the laboratory findings compared with the results of field studies. It is concluded that information from laboratory experiments and field surveys should make possible reasonable predictions about the contamination of marine invertebrates if the level of activity in the sea water in particular environments is known or can be estimated. (auth)

24257 MEASUREMENT OF STRONTIUM 90 AND CAESIUM 137 IN FISHES. W. Feldt (Bundesforschungsanstalt für Fischerei Institut fur Fischverarbeitung, Hamburg). p.105-11 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Results of measurements of Sr-90 and Cs-137 in fish from different areas show a marked dependency on water salinity. This is explained theoretically with supporting evidence from measurements. From gamma analysis it appears that particulate compounds of Zr and Ce, which are suspended in river water, deposit in sediments or separate out as flocculent precipitates upon mixing with sea water. (auth)

24258 CHEMICAL COMPOSITION AND THE RADIOCONTAMINATION OF MARINE ORGANISMS. M. Bernhard (Comitato Nazionale per l'Energie Nucleare, Rome). p.137-50 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Equations are developed to assist prediction of internal radiocontamination of marine organisms from existing data on the chemical composition of the organisms and sea water. The treatment covers growth and replacement accumulation of radioisotopes under conditions of constant and changing specific isotope content. Data are included for the chemical composition of protozoa, fish, invertebrates, algae, and sea water. (auth)

Radiation Effects

24259 (BNL-898) THE GASES OF THE BLOOD. Donald D. Van Slyke (Brookhaven National Lab., Upton, N. Y.). Nov. 18, 1964. Contract AT-30-2-GEN-16. 18p. Dep.; $1.00(cy), 1(mn) CFSTI.

Brookhaven Lecture Series No. 41.

The physiology of blood gases is reviewed. Emphasis is placed on the role of oxygen, carbon dioxide, nitrogen, and the effect of oxygen pressure on the radiosensitivity of tumor tissues. (C.H.)

24260 (NASA-CR-53780) [INTERDISCIPLINARY STUDIES OF THE EFFECTS OF HIGH-ENERGY PROTONS ON BIOLOGIC SYSTEMS]. Semi-Annual Status Report, July 15, 1963–January 15, 1964. Raymond N. Kjellberg (Massachusetts General Hospital, Boston). Feb. 17, 1964. 40p. (N64-19352). $3.60(CFSTI).

Progress is reported in the detailed mapping of dose distributions from proton beams of various diameters. The mean linear energy transfer of various depth of penetration was measured for 3 mm and 7 mm beams. Data pertinent to dosimetry and proton beam monitoring were assembled. Data are included from γ absorption coefficient measurements in various types of human tissue, studies on the effect of low-dosage long-term proton radiation in bacteria, and the pathology of brain lesions in monkeys induced by protons at various depths of penetration. The observations indicate that the ionization per rad is more destructive towards the end of the range where LET is higher. Data are included from an analysis of the biological effects of protons in various biological systems, experimental animals, and man. (C.H.)

24261 (TID-21649) INVESTIGATIONS OF MUTABILITY OF POLYGENES AND ON UTILIZATION OF INDUCED GENETIC VARIABILITY. R. E. Scossiroli (Pavia Univ. (Italy). Istituto di Genetica and Catania Univ. (Italy). Istituto di Genetica). Jan. 1, 1965. Contract IAEA 61/US. 57p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are presented from an analysis of radioinduced mutations in wheat. Seeds of Triticum durum and a diploid species, T. monoccum, were exposed to various doses of x radiation ranging from 1500 to 8000 R and plants from four generations were analyzed for a series of characters, including productivity. The use of radioinduced mutations in plant breeding programs is discussed. (C.H.)

24262 (TID-21780) THE ACTION OF RADIATIONS ON SOME BIOLOGICAL MODEL SYSTEMS. Progress Report, June 12, 1964–April 1, 1965. G. Stein (Hebrew Univ., Jerusalem (Israel)). Contract AT(30-1)-3242. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in studies on the mechanisms of action of ionizing radiations on biological model systems. Results are summarized from studies on the specificity of the action of atomic H on amino acids and proteins forming parts of enzymes. The rate constants of atomic H with a number of different substances were determined and compared with those derived from radiation chemistry. Data are presented on the action of H on trypsin and chymotrypsin in aqueous solution, amino acids, peptides, ribonuclease, and cytochrome C. The role of excited states in the reactivity of molecules and energy transfer mechanisms were also investigated. (C.H.)

24263 (JPRS-29452(p.62-71)) ON THE EFFECT OF C^{14} ON DEVELOPING OVA AND LARVAE OF FRESHWATER FISH. G. V. Fedorova. Translated from Vopr. Ikhtiol., 4: 723-8(1964).

Increasing the concentration of ^{14}C to $2 \cdot 10^{-5}$–$2 \cdot 10^{-4}$ curies per liter had an unfavorable influence upon the embryonic development of freshwater fish. The death of fish ova incubated in water with a ^{14}C activeness equal to $2 \cdot 10^{-5}$ to $2 \cdot 10^{-4}$ curies per liter was significantly higher than in the control; the hatching speed of larvae from ova contaminated with ^{14}C with statistical reliability differs from the hatching speed of noncontaminated larvae; in the radioactive larvae of the alburnum, striped perch, and roach one could observe somewhat more deformed larvae than in the control. No clear difference could be established in the survival rate for the larvae of the crusian carp, alburnum, and roach grown in contaminated water and in the control. The mortality rate for the striped perch larvae in radioactive water was higher than in the control. (auth)

24264 (JPRS-29606) THE USE OF FREE PHAGE AND THE SYSTEM PHAGE-BACTERIUM IN STUDYING THE PRIMARY BIOLOGICAL EFFECT OF IONIZING RADIATION. G. E. (Ye.) Fradkin. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., No. 1, 44-52(Jan.-Feb. 1965). 13p. (TT-65-30745). $1.00(CFSTI)

The production of virulent mutants in populations of moderate phage lambda was determined after exposure to γ radiation under conditions of prevalently indirect or direct actions of radiation. It was concluded that the virulent mutations were a peculiar genetic form arising from partial damage of the DNA of moderate phages. Analysis of the data indicated that the memory apparatus of DNA contains the protein synthesis program, including the enzymes; the code, as is known, is degenerative whereas in the controlling apparatus information determining the construction of repressor, apparently is not coded in excess. The high susceptibility to radiation injury of the genetic structure functions can be conditioned not only by peculiarities of their physico-chemical organizations but also in the character of the information coded in the DNA. The presence or absence of degeneration or dysgenicity of the code in the functionally non-homogeneous portions of DNA can be a cause of the varying resistance of the genetic functions to radiation. (C.H.)

24265 THE EVOLUTION OF EXPERIMENTAL ENCEPHALITIS IN MICE INFECTED WITH THE TICK VIRUS AND EXPOSED TO IRRADIATION WITH β AND γ RAYS. N. Cajal, N. Draganescu, and O. Burducea (Institutul de Inframicrobiologie al Academiei R.P.R., Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Inframicrobiol., 14: 17-21(1963). (In Rumanian)

By intraperitoneal inoculation of 25 μC Na ^{131}I and $Na_2H^{32}PO_4$, in isotonic solutions, to white hybrid mice previously injected by intracerebral route with the tick-borne encephalitis virus, strain F (Bucharest), the evolution of this viral disease was studied under the influence of beta and gamma radiations emitted by radioiodine and radiophosphorus. In comparison with the controls, the incubation period and the duration of the disease was shorter in the animals treated with radioisotopes, particularly in those exposed to the action of beta and gamma radiations emitted by ^{131}I. Similarly, in the animals with experimental encephalitis, the virus was synthetized in greater amounts under the action of radioactive iodine than in the controls, the most marked differences being observed in the brain, whereas in the ^{32}P treated animals, the virus did not find favorable conditions, with exception of the spleen, where the titer was higher than in the controls. Hence, the question arises whether the recent thermonuclear tests didn't raise the radioactive threshold in nature thus determining a real invasion of viruses inclusively the encephalitis viruses. (auth)

24266 A CASE OF POSTANGIOGRAPHIC Th DEPOSITION AND PRIMARY SQUAMOUS-CELL CARCINOMA OF THE LIVER. B. Larsson. Acta Pathol. Microbiol. Scand., 58: 389(1963).

In the case reported, bilateral cerebral angiography had been performed with a total of 17 ml of Thorotrast. Twenty-seven years later the 53-year-old male succumbed from a

large necrotizing liver tumor, squamous-cell in type. Total-body scintillography after administration of colloidal ^{198}Au had shown no uptake in the region of the spleen before surgical splenectomy. Metastases were found in regional lymph nodes, peritoneum, adrenal regions, and in one thoracic vertebra. There were no ThO_2 deposits at the sites of injection. The liver weighed 1800 g and revealed a moderate and mainly postnecrotic scarring. Thorotrast deposition was demonstrated in liver and spleen with routine methods and autoradiography. The bone marrow was in a reactive state, and moderate anemia was present. (BBB)

24267 INFLUENCE OF DIFFERENT CULTURE CONDITIONS IN GREEN AND COLORLESS CELLS OF EUGLENA GRACILIS ON THEIR SURVIVAL AFTER X-RAY IRRADIATIONS. G. V. Kasinova (Inst. of Cytology, Academy of Sciences, Leningrad). Acta Protozool., 2: 279-85 (Sept. 1, 1964). (In Russian)

Studies were conducted on the effect of culture conditions after x irradiation on survival of cells of three strains of Euglena gracilis: (1) chlorophyllous, (2) colorless, but becoming chlorophyllous in the light, and (3) colorless and remaining so in the light. The maintenance of the Euglena cells after irradiation on organic and inorganic medium as well as in the light and in darkness, allowed data to be obtained on such combinations of the culture conditions which permitted: (1) both hetero- and autotrophic feeding, (2) heterotrophic feeding only, and (3) autotrophic feeding only. After excluding photosynthesis (i.e. in experiments conducted in darkness), the number of surviving cells after x-ray exposure at doses of 30.2 and 151 kR proved to be the same for all three strains, while at the dose of 302 kR the percentage of survival was less in chlorophyllous cells than in the colorless ones. The maintenance of the Euglena cells under light + organic nutrient culture conditions increased the survival of the strains 1 and 2 much more than that of strain 3. Maintenance under light + inorganic media culture conditions resulted in the complete lethality of the strain 1 at the 151-kR dose or higher. The results suggest that autotrophic feeding alone is not sufficient to ensure the survival of colored Euglena exposed to 151 kR or more, but the presence of development (after exposure) of the photosynthetic apparatus in a cell enhances its survival under light + organic media culture conditions. Disintegration of chloroplasts and disappearance of chlorophyll were seen in Euglena green cells after x-ray treatment. (BBB)

24268 RADIATION BIOLOGY AND SPACE ENVIRONMENTAL PARAMETERS IN MANNED SPACECRAFT DESIGN AND OPERATIONS. Wright H. Langham, ed. (Los Alamos Scientific Lab., N. Mex.), Phillips M. Brooks, ed. (McDonnell Aircraft Corp., St. Louis), and Douglas Grahn, ed. Aerospace Med., 36: No. 2, Sect. II, 61p. (Feb. 1965).

Criteria are presented for consideration of man's response to space radiation exposure so that radiation risks may be taken into account during spacecraft design and operational planning. It is pointed out that the only basis for derivation of such criteria is the vast amount of data on effects of low and intermediate energy electromagnetic and particulate radiations on animals and occasionally on man and exposures in space will present different conditions of exposure and the nature, energy, and spectral distribution of the radiations will also be different. Some of the general and specific aspects of the space radiation environment are discussed and exposure conditions that may be encountered are postulated. Topics discussed in detail include the space radiation environment, the biological effects of ionizing radiation, the state of current knowledge, and applications of this knowledge to space flight operations. (286 references) (C.H.)

24269 STUDIES OF LATENT Q FEVER INFECTIONS. I. EFFECTS OF WHOLE-BODY X-IRRADIATION UPON LATENTLY INFECTED GUINEA PIGS, WHITE MICE, AND DEER MICE. Robert W. Sidwell (Southern Research Inst., Birmingham, Ala.), Bert D. Thorpe, and Louis P. Gebhardt. Am. J. Hyg., 79: 113-24 (Jan. 1964).

Latent infections of Coxiella burnetii in guinea pigs and mice were studied in attempts to reactivate the infections by x irradiation, a stressor agent which can cause alterations of many physiological processes in infection. The Q fever antibody response in these animals and a study of the transmission of the disease agent are also reported. Irradiation doses for the reactivation study were selected to be slightly less than or greater than the LD_{50}, termed the low and high doses, respectively. For guinea pigs, these were 100 and 175 R (LD_{50} = 163 R); for white mice, 300 and 450 R (LD_{50} = 431 R); and for deer mice, 350 and 625 R (LD_{50} = 588 R). The animals were inoculated with C. burnetii and all animals were then held for 90 days, after which they were divided into 3 groups: controls, which were infected but not irradiated; infected animals that received a low dose of x irradiation; and infected animals that received a high dose of x irradiation. Whole-body irradiation in doses slightly less than or greater than the 21-day LD_{50} caused a definite reactivation of C. burnetii in guinea pigs infected 3 months previously. This reactivation was determined by demonstration of the organism in various tissues and in the urine and feces of these animals, as compared to the detection of few or no rickettsiae in the same tissues from nonirradiated similarly infected control animals. There was no conclusive evidence of reactivation, on the basis of recovery of organisms, in deer mice or white mice similarly treated, although some evidence of reactivation in white mice was indicated by a transmission of C. burnetii to control mice housed as cage mates with the treated animals. Such a transmission was also observed among the treated guinea pigs, but none could be detected in the deer mice or in nonirradiated control animals. The Q fever antibody responses to phase I and II complement fixation (CF) and phase I capillary tube agglutination antigens were shown to vary markedly in titer with animal species, dose of irradiation, and type of antibody. A week after high-dose irradiation of guinea pigs, there was a slight depression of Q fever CF antibody, followed by a significant increase in titer by 28 days; a destruction of antibody-forming cells had apparently occurred. This was followed by regeneration of these cells and re-stimulation by reactivated C. burnetii. No increase in titers were noted in sera from animals that received low doses of x rays, indicating suppression of antibody production with not enough organisms being reactivated to cause a restimulation or indicating that the x irradiation had no effect whatever on the antibody response in this group of animals. The same general trend was also noted in white mice and deer mice. (BBB)

24270 RESISTANCE OF CLOSTRIDIUM PERFRINGENS TYPE A SPORES TO γ-RADIATION. T. F. Midura, L. L. Kempe, J. T. Graikoski, and N. A. Milone (Univ. of Michigan, Ann Arbor). Appl. Microbiol., 13: 244-7(Mar. 1965).

The radiation resistance of the spores of a classical strain and of an atypical, heat-resistant strain of Clostridium perfringens was determined. Spores were produced in Ellner's and in a Trypticase broth medium. Approximately 10^6 viable spores per milliliter were suspended in 0.06 M phosphate buffer and irradiated with γ rays from cobalt-60; the survivors were counted in Tryptone-yeast extract-agar by the Prickett-tube technique. Radiation D values for spores of the atypical strain in phosphate buffer and in cooked-meat broth were 0.23 and 0.30 Mrad, respectively, and the D value of the classical strain was 0.25 Mrad in phosphate buffer. Spores of the classical and atypical strains of C. perfringens type A are characterized by differences in heat resistance; yet, all strains tested demonstrated similar radiation resistance. Also, the spores were more resistant to ionizing radiation in cooked-meat broth than in phosphate buffer. (auth)

24271 THE ACTIVITY OF DEOXYRIBONUCLEASE ACID AND THE LABILIZATION OF DEOXYRIBONUCLEIC ACID IN THE THYMUS AND REGENERATING LIVER AFTER TOTAL IRRADIATION IN THE RAT. R. Goutier, M. Goutier-Pirotte, and A. Raffi (Centre d'Étude de l'Énergie Nucléaire, Mol, Belg.). Arch. Intern. Physiol. Biochim., 72: 519-20(June 1964). (In French)

The activity of desoxyribonuclease (DNase) at acid pH increased in lymphoid tissue after irradiation and underwent changes in intracellular distribution. To understand the re-

lation between changes in acid DNase and the appearance of cytological lesions, a study was made of the thymus and liver, where cytological lesions appear differently after irradiation. Measuring the amount of extractible DNA in the organs made possible the determination of the degree of instability of the bonds between DNA and its protein. In the thymus, two hr after exposure to 700 R the activity of acid DNase increased. It increased again at six hr. The proportion of free acid DNase increased two hr after irradiation and then remained constant. Also two hr after exposure, the labilization of DNA began and continued to increase. In regenerating liver, irradiation does not influence the normal rise in activity of DNase acid or the labilization of DNA, although the proportion of soluble enzyme is temporarily increased. The greater lability of DNA is a function of the increased activity of acid DNase and not of the increased amount of the enzyme in the cytoplasm. (BBB)

24272 STUDIES ON ADJUVANT-INDUCED POLYARTHRITIS IN RATS. III. THE EFFECT OF IMMUNOSUPPRESSIVE AGENTS ON ARTHRITIS AND TUBERCULIN HYPERSENSITIVITY. John R. Ward, R. Sidney Cloud, Edward L. Krawitt, and Russell S. Jones (Univ. of Utah, Salt Lake City). Arthritis Rheumat., 7: 654-61(Dec. 1964).

In rats, a single intradermal injection of Freund-type adjuvant was used to induce polyarthritis. Methotrexate, 6-mercaptopurine, and total-body x irradiation, given to rats injected with mycobacterial adjuvant, suppressed the development of polyarthritis without altering hypersensitivity to old tuberculin. Mechlorethamine hydrochloride was without effect. This dissociation of arthritis and tuberculin hypersensitivity suggests that sensitization to tuberculoprotein plays no direct role in producing the arthritis. Methotrexate and 6-mercaptopurine also suppressed the early inflammation at the site of adjuvant injection indicating an anti-inflammatory action which is independent of their effects on immunologic mechanisms. (BBB)

24273 BEHAVIOR OF GLUTAMIC-OXALACETIC TRANSAMINASE IN ANIMALS DURING RADIOTHERAPY. M. Goffrini and P. Catelli (Instituti Ospedalieri, Cremona). Boll. Soc. Med.-Chir. Cremona, 15: 231-8(Oct.-Dec. 1961). (In Italian)

The humoral effects produced by irradiation are discussed on the basis of physicochemical changes in composition of the interstitial fluids. Serum glutamic-oxalacetic transaminase activity was studied in liver-irradiated guinea pigs. The following values were observed in blood samples taken before irradiation, 21.6 units/ml/min; two days after irradiation with 5950 R, 93 units; five days after a second irradiation to a total of 9500 R in blood samples taken 48 hr later, 59.8 units; ten days after a third irradiation totaling 11,400 R, 56.3 units; and final sample on the surviving irradiated animals after one month, 40.7 units. Thus a marked increase of serum glutamic-oxalacetic transaminase activity due to radiotherapy was observed, maximum increase being observed at the half-way point of the treatment. No variation of the values was observed in relation to the animal's sex. The increase of this activity was not proportional to the total dose and apparently not directly related to the type of radiation used. Because of the rapid rise and fall of the serum enzymatic activity, it was suggested that other secondary factors were involved. The increase of serum glutamic-oxalacetic transaminase activity was attributed mainly to cell necrosis caused by the ionizing radiation. (TCO)

24274 PRECOCIOUS LEUKEMIAS APPEARING IN NEWBORN AND YOUNG ADULT AkR MICE EXPOSED TO X RAYS. Pierre Jullien and Georges Rudali (Fondation Curie, Paris). Bull. Assoc. Franc. Etudes Cancer, 51: 147-52(1964). (In French)

In AkR mice the frequency of spontaneous lymphoid leukemias is ~80%, with an average latency of nine months. In the first experiment, mice were exposed to 120 R x radiation once a week for five weeks, beginning either at birth or at the age of 45 days. In the newborns, leukemia frequency was 82%. The leukemias appeared at 4.8 months of age after a latency of 3.9 months. Irradiated nonleukemic newborns died precociously. Leukemias occurred in 81% of the adult mice at an average 7.5 months, with a latency of 5.2 months. The control mice had 81% leukemias, appearing at an average age of 9.1 months. Induced leukemias had the same characteristics as spontaneous ones. In a second experiment mice received 150 R x rays at four-day intervals for a total dose of 600 R. Of those irradiated from birth to 15 days, 83% developed leukemias. The average age of appearance was 4.2 months with a latency of 3.7 months. Irradiation between the 15th and 30th days caused leukemias in 87% of the mice. The average age was 5.2 months and the latency, 4.2 months. Exposure to x rays from the 30th to the 45th day caused 84% of the mice to develop leukemia. The average age was 6.7 months and the latency, 5.2 months. Of the control mice, 82% developed leukemia at an average age of 8.7 months. Sensitivity to irradiation decreases significantly at the age of puberty. A change in the thymus, which dominates the lymphatic system in the first weeks of life, is a possible explanation of the sensitivity of newborn AkR mice to the leukemogenic influence of x rays. (BBB)

24275 PRODUCTION OF RADIOLEUKEMIAS IN XVII/G MICE AND F_1 (XVII/G x AkR) HYBRIDS. G. Rudali, P. Pujol, P. Jullien, and J. Reverdy (Fondation Curie, Paris). Bull. Assoc. Franc. Etudes Cancer, 51: 153-7(1964). (In French)

XVII/G mice are quite resistant to leukemogenic agents. Irradiation of AkR mice from birth greatly decreases the latency time of leukemias. Pure strain XVII/G and hybrid F_1 (XVII/G x AkR) mice were exposed to 120 R of x rays once a week for five weeks, either from birth or from the age of 40 days (adult). In the XVII/G adult mice irradiation did not increase the mortality rate, but 7% of the mice developed leukemias. In the newborn XVII/G, only 89 of 209 lived 30 days and only 20 (10%) lived five months. Of these, 15% developed leukemias. There were no leukemias in the control group. In the hybrid adult mice there was no precocious mortality, but leukemias appeared in 50% of the mice. Of the 150 newborn hybrids, 75% lived more than five months, but 70% developed leukemias. All leukemias were of lymphoid origin, manifested by thymic lymphosarcomas. A difference in sensitivity to irradiation was observed between males and females. In hybrids irradiated since birth, 76% of the females developed leukemias, while only 64% of the males did. In hybrids irradiated from the age of six months, 61% of the females and 37% of the males developed leukemia. Salivary tumors also appeared in the XVII/G mice, probably due to a decrease in the number of antibodies to a virus after irradiation. It is not known if the sensitivity to irradiation of the F_1 (XVII/G x AkR) hybrid is due to genes determining the radiosensitivity or the susceptibility of the AkR strain to the Gross leukemia virus. (BBB)

24276 EFFECT OF IONIZING RADIATION ON THE δ-AMINOLEVULINIC ACID SYNTHETASE OF CHICKEN ERYTHROCYTES. T. Malinowska and A. M. Dancewicz (Inst. for Nuclear Research Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Biol., 13: 13-16(1965).

The susceptibility of δ-aminolevulinic acid (ALA) synthetase in chicken erythrocytes to x irradiations was investigated. The results showed that the activity of ALA synthetase decreased significantly but only after exposure to 100,000 R. This suggests that ALA synthetase is rather resistant to irradiation. Possible reasons for this are discussed. (P.C.H.)

24277 IRRADIATION DOSAGE FOR PULMONARY TUBERCULOSIS AND THE PROBABILITY OF RADIOLEUKEMIA. Paul Kayser (Direction de la Sante Publique, Luxembourg). Bull. Soc. Sci. Med. Luxembourg, 101: 119-25 (June 1964). (In French)

Evidence is reviewed which relates development of leukemia to previous radiation exposure. It is known that large doses of irradiation in a short time or in intermittent doses to the bone marrow can induce leukemia. The question is whether diagnostic irradiation given during the treatment of pulmonary tuberculosis falls in this category. The average

radiation dose received for following the progress of pulmonary tuberculosis is estimated at about 110 R/yr (assuming each fluoroscopic examination lasts one min) for an average of five years. So, 500 R is received by the bone marrow in the course of five years. A study of the U. S. National Research Council showed that in an average population there were 70 cases of leukemia per million per yr. For a person who received 500 R to the blood-forming tissues and later developed leukemia, the chances were 7 to 14 to one that the leukemia was induced by the irradiation. This gives a probability of 86.9 to 93%. In Bousser's study in Paris of 321 cases of leukemia, 100 had not received previous irradiation. Twenty-two had had multiple irradiations, 13 of which were cases of pulmonary tuberculosis. Compared to the incidence in the general population, this deviation can be laid to the irradiation. The work of Bergmann established that 0.9% of pulmonary tuberculosis patients later developed leukemia. In a report by Faber, in Denmark, 61.9% of the subjects who developed chronic myeloid leukemia had previously undergone irradiation for diagnostic purposes. All the results mentioned apply to doses of 100 R or more and to a post-irradiation period of less than ten years. After ten years the frequency of leukemia in irradiated persons falls to normal. An additional 30 to 50 R doubles the frequency of leukemia. Experiments with mice by Melching indicated that low, repeated doses given over a period of time, as in the treatment of tuberculosis, were more leukemogenic than single strong doses. (BBB)

24278 DIFFERENTIATION BETWEEN RADIATION-SENSITIVE AND -RESISTANT MUTANTS OF ESCHERICHIA COLI, STRAIN B. E. E. Woodside (Univ. of Louisville, Ky.). Can. J. Microbiol., 11: 243-58(Apr. 1965).

Morphological heterogeneity in cell sizes of Escherichia coli, strains B, B/r, and B_s prevents estimation of the viable cell count by the indirect turbidimetric method. The average dry weights of E. coli B, B/r, and B_s, when grown in acetate synthetic medium, are 0.16, 0.10, and 0.13 picograms per cell, respectively. Increased radiosensitivity was correlated with those bacterial populations showing decreased intracellular glycogen content, decreased lipopolysaccharide–lipoprotein content, R-colony forms, and cellular elongation. The radiosensitive strains contained more DNA, RNA, and protein per cell than the radioresistant mutant; however, no significant differences were evident in the DNA, RNA, and protein contents on a dry weight basis. No qualitative differences in the monosaccharides or their derivatives were found. Intracellular glucose synthesis and accumulation preceded DNA, RNA, and protein synthesis throughout the lag and early logarithmic growth phases for all three strains. Multiple forms of intracellular glycogen complexes were present in all three strains. In addition to unbound glycogen and protein-bound glycogen, a bound form of glycogen was consistently associated with crude fractions which contained the DNA, RNA, and lipopolysaccharide constituents. Increased lability of the cold TCA-insoluble bound glycogen to hot TCA and alpha-amylase hydrolysis was correlated with increased radiosensitivities of the organisms. (auth)

24279 A CYTOLOGICAL STUDY OF NORMAL AND RADIATION-RESISTANT ESCHERICHIA COLI. R. D. Pontefract and F. S. Thatcher (Food and Drug Directorate, Ottawa). Can. J. Microbiol., 11: 271-8(Apr. 1965).

A series of cultures of Escherichia coli exhibiting resistance to gamma irradiation was studied cytologically. The length of the cells in the cultures increased as the resistance to irradiation increased. The most resistant cultures contained a high percentage of long filamentous cells 30–40 times longer than normal. A striking increase in the apparent number of nuclei per cell accompanied cellular elongation. These resistant cells also exhibited a peculiar budding phenomenon which only occurred in the more radiation-resistant cultures. Conjectures are offered on the relationship between these findings and a basis for resistance to irradiation. (auth)

24280 INFLUENCE OF THYMECTOMY FOLLOWED BY X IRRADIATION AND AN ISOLOGOUS RESTORATION ON THE PERCENTAGE OF IMMUNOGLOBULINES IN THE MOUSE. Herve Bazin and Jean-Francois Duplan (Institut du Radium, Paris). Compt. Rend., 260: 2091-4(Feb. 15, 1965). (In French)

Thymectomized mice, irradiated then restored by isologous fetal liver, had, 150 days after irradiation, a higher percentage of γ-globulin than that of non-thymectomized animals that underwent the same treatment. This increase bears essentially on the Ig G_2. Moreover, some thymus-poor mice of this group had disglobulinemia. (tr-auth)

24281 CONTRIBUTION TO THE STUDY OF THE NEUROSECRETION IN THE EARTHWORM ALLOLOBOPHORA CHLOROTICA SAV. EXPOSED TO THE EFFECT OF LIGHT RADIATIONS. James Maissiat (Faculte des Sciences, Poitiers, France). Compt. Rend., 260: 2606-8 (Mar. 1, 1965). (In French

The neurosecretion cells of Allolobophora chlorotica Sav. exposed to the effects of light radiations underwent a regressive evolution that resulted in an arrest of their activity. This arrest is a function of the total time of lighting. The small cells a completely disappear. After a latency period of 2 or 3 days, the neurosecretion reappeared except for the subjects treated by radiations containing the infrared. (tr-auth)

24282 AUGMENTATION OF THE PERCENTAGE OF ANTIBODIES FOLLOWING A STRONG LOCAL IRRADIATION. Jean Loiseleur and Michelle Petit (Institut Pasteur, [Paris]). Compt. Rend., 260: 2956-7(Mar. 8, 1965). (In French)

The administration of a high dose of x rays on one of the limbs of a rabbit, at a time between the first two injections of an antigen, caused a considerable augmentation of the percentage of the antibodies. (tr-auth)

24283 INCREASE OF THE PERCENTAGE OF TETANUS AND DIPHTHERIA ANTIBODIES FOLLOWING THE ACTION OF X RAYS. Jean Loiseleur, Olivier Girard, and Michelle Petit (Institut Pasteur, [Paris]). Compt. Rend., 260: 3230-1(Mar. 15, 1965). (In French)

X rays, administered to guinea pigs that had received two successive injections of a mixture of tetanus and diphtheria anatoxins, caused a significant increase in the percentage of antibodies. The irradiation should be made at a time between the two injections. The x-ray dose should be low if the whole organism is to be exposed or high if the irradiation is to be localized on one of the limbs. (tr-auth)

24284 RADIATION AND CARCINOMA OF THE THYROID. Dorothy R. Hollingsworth (Yale Univ., New Haven). Conn. Med., 27: 762-5(Dec. 1963).

A review is presented summarizing the current literature on the relation of radiation and carcinoma of the thyroid. Experiments on thyroid carcinogenesis in the rat suggest that radiation may initiate neoplastic cells perhaps in a manner comparable to that of the carcinogen 2-acetylaminofluorene and these cells are then promoted to tumor formation by the goitrogen-induced TSH stimulation. Large and small doses of ^{131}I increase TSH secretion in experimental animals. The dose of ^{131}I is important, however, because after very large doses the thyroid is unable to respond to the stimulus of increased TSH. The combination of goitrogens and irradiation has been found to be particularly effective in causing thyroid tumors. Attention is also called to the development of thyroid carcinoma in children following x irradiation to the head and neck following treatment for enlarged thymus, tonsillar hypertrophy, mastoiditis, sinusitis, and cervical tuberculous lymphadenitis. The infant thyroid presents an ideal setting for carcinogenesis since its rapidly developing cells are quite sensitive to irradiation. Evidence linking carcinoma of the thyroid with irradiation in children continues to accumulate. A study in 1955 pointed out for the first time that relatively small doses of radiation (200 to 600 R) might be responsible for thyroid tumors in man. However, in contrast to the growing literature implicating radiation and subsequent thyroid carcinoma in children, there is a paucity of information available for adult populations who were irradiated either during childhood or adulthood. Patients receiving head, neck, and chest irradiation during adoles-

cence and adult years for varying reasons as well as patients receiving ^{131}I will have to have prolonged follow-up if valid data are to be collected on older age groups. Since the first use of ^{131}I for thyrotoxicosis in 1943, not a single case of carcinoma of the thyroid has been reported. However, by 1960, 18 cases of leukemia had been documented following ^{131}I, as well as 4 leukemias in 140 cases of thyroid cancer treated with ^{131}I. In the cancer cases there was most likely a direct relation with the therapy as the average dose was 735 mC. Statistically, at present the incidence of leukemia in hyperthyroid patients treated with ^{131}I does not exceed the expected number of cases in the general population. (BBB)

24285 ACANTHOGENIC EFFECTS OF DIFFERENT-QUALITY X RAYS. A Maggiora and R. Brun (Universite de Dermatologie, Geneva). Dermatologica, 125: 39-43 (1962). (In French)

The same dosage of x rays (1600 R) but of different quality was given to the flanks of guinea pigs. The values varied from 10 to 50 kv, Dermopan, positions I, II, III, and IV. The acanthosis produced by the different qualities of x rays was not significantly different. (auth)

24286 STUDIES ON THE PROBLEM OF THE RAPID IDENTIFICATION OF BIOLOGICAL EFFECTS OF X RAYS. PART FIVE. ON THE TRYPAN BLUE REACTION OF THE SKIN AFTER X IRRADIATION. R. Schuppli and H.-H. Wagener (Universität, Basel). Dermatologica, 129: 271-80 (1964). (In German)

The skin is very sensitive to irradiation, which often results in increased capillary permeability. This effect can be detected after intravenous or intraperitoneal injection of certain dyes by observing the intensity and spread of discoloration produced by the dye within the area irradiated. The authors demonstrated increases in capillary permeability in guinea pig skin resulting from x irradiation by means of this type of dye-diffusion test. For this purpose the animals were injected with 20 mg/kg body wt of trypan blue 5 min before they were irradiated with a surface of 20000 R of x ray. The dye pontamine sky blue 6BX was also used similarly. Discoloration of the skin was observed also when the dye was given 30 or 60 min after irradiation, but when the dye was given only 10 min after irradiation, the color diffusion was irregular and much less definite. When the test was performed on animals that had received a vitamin-free diet, or one that contained a combination of vitamin C and rutin, for 8 days, there was no lessening of the skin color reaction. The coloration extended only to the limits of the field irradiated, suggesting that it depended exclusively on the direct injury of the capillaries by the radiation administered. (BBB)

24287 A DEVELOPMENTAL-GENETIC STUDY ON PANICLE CHARACTERS IN RICE, ORYZA SATIVA L. Kan-Ichi Sakai and Yoshiya Shimamoto (National Inst. of Genetics, Misima, Japan). Genet. Res., 6: 93-103(Feb. 1965).

By comparing genetic correlations between an x irradiated and a control population of rice, parameters for the strength of pleiotropic effects of quantitative genes were estimated. It was found that the gene-set, which is responsible for main rachis formation and is therefore of primary importance for panicle formation, pleiotropically controls the development of rachillas and basal internode. Pleiotropic control over the development of higher rachillas is very powerful but less strong over the lower ones and basal internode. Developmental relationships among these characters were also investigated by measuring the genetic correlations between their developmental instabilities. The basis of the inference is the hypothesis that if two characters that are found to be pleiotropically controlled by the same set of genes take their own developmental paths from a very early stage, they will show only slight correlation between their developmental instabilities. If, on the contrary, they are taking the same developmental path and their differentiation sets in late, the correlation coefficient will be high. (auth)

24288 INDUCED MITOTIC CROSSING-OVER IN RELATION TO GENETIC REPLICATION IN SYNCHRONOUSLY DIVIDING CELLS OF USTILAGO MAYDIS. Robin Holliday (Univ. of Washington, Seattle). Genet. Res., 6: 104-20(Feb. 1965).

A method is now available for synchronizing the division of populations of cells of the smut fungus Ustilago maydis. In two experiments carried out with a diploid strain heterozygous for several biochemical markers, samples of cells were removed at intervals through the synchronized division cycle and treated with a constant dose of ultraviolet light. Cell survival and the frequency of the various recombinants resulting from induced mitotic crossing-over were recorded. In addition the period of DNA synthesis in the unirradiated population was measured. During this period the cells are very sensitive to ultraviolet light and those that survive contain the highest proportion of induced recombinants. In so far as the markers make it possible to locate the position of cross-overs, cells that are irradiated early in the period of genetic replication show most crossing-over towards the ends of the chromosome arms, while cells that are treated late in this period show crossing-over near the centromeres. The data are most easily interpreted by supposing that chromosome replication begins at the ends of the arms and proceeds to the centromere, and that the temporary interruption of this process by ultraviolet light can result in pairing and crossing-over in the vicinity of the points of interruption. (auth)

24289 INDUCTION OF DOMINANT LETHAL MUTATIONS IN INSECT OOCYTES AND SPERM BY GAMMA RAYS AND AN ALKYLATING AGENT: DOSE-RESPONSE AND JOINT ACTION STUDIES. Leo E. LaChance and Maxwell M. Crystal (Dept. of Agriculture, Mission, Tex.). Genetics, 51: 699-708(May 1965).

Adult female screw-worm flies containing oocytes in early prophase or early anaphase of the first meiotic division, and 1-day-old males containing mature sperm were exposed to graded doses of gamma radiation or the alkylating agent, 2,4,6-tris (1-aziridinyl)-s-triazine (=tretamine). Frequency of dominant lethal mutations induced by these treatments was determined by scoring hatchability of eggs produced by inseminated females. Crosses involved treated females x untreated males or the reverse. Dose-response curves permit a comparison of radiation and tretamine treatments on the three stages of reproductive cells that differ greatly in their sensitivity to both radiation and chemical mutagens. Shapes of curves for both radiation and tretamine treatments are remarkably similar for the same cell stage. The relationship between dose and percentage of dominant lethals was nonlinear for all cell stages. In testing for possible potentiation of one treatment by the other when treatments were applied consecutively, adult males and females were exposed to tretamine followed in 16 minutes by an exposure to gamma radiation. Doses used were known to produce less than 50% dominant lethals when given alone. Treated insects were crossed to untreated ones and frequency of dominant lethal mutations induced by combined treatments compared with those by single treatments was assessed. Results indicated that the effect of combined treatments on oocytes and sperm was merely additive, at best. Possible reasons for similarity of the dose-response curves elicited by basically different types of mutagens, shapes of curves, and absence of potentiation when treatments included both radiation and tretamine are discussed. (auth)

24290 THE FREQUENCY OF X-RAY INDUCED DOMINANT MUTATIONS AFFECTING THE SKELETON OF MICE. U. H. Ehling (Oak Ridge National Lab., Tenn. and Institut fur Biologie Gesellschaft fur Strahlenforschung, Munich). Genetics, 51: 723-32(May 1965). (ORNL-P-643)

New data are given that strongly support earlier results showing that it is possible to measure part of the overall genetic damage of irradiation by skeletal studies in the F_1 generation. It was assumed that in a sample of 2,094 F_1 mice, not more than one mutation would be expected for any particular gene locus and, therefore, that some distinction between defects of mutant and nonmutant origin might be made by merely dividing the abnormalities according to whether they occurred only once in the whole experi-

ment (Class 1), or more than once (Class 2). With this classification, a statistically significant increase of abnormalities in one or several subgroups of Class 1 is expected to provide a sensitive indication of mutations. The data support this expectation. The manifestation of Class-2 abnormalities showed no statistically significant dependence on the treatment of the males. For Class-1 abnormalities, a highly significant increase in frequency was observed in offspring of irradiated males. The main difference in the frequency of Class-1 abnormalities between irradiated and control groups is due to Class-1 multiple abnormalities. The most significant features of the results, from the point of view of human hazards, are, first, that the frequency of individuals with multiple skeletal abnormalities in first generation offspring of irradiated males is high, at least for the exposure of postspermatogonial germ cell stages; and, second, that the majority of these radioinduced genetic effects on the skeleton are probably deleterious to various degrees. (auth)

24291 EFFECTS OF DNA BASE ANALOGUES ON THE SCALES OF THE WING OF EPHESTIA. Ernst Caspari, Wilhelm Muth, and H.-J. Pohley (Univ. of Rochester, N. Y.). Genetics, 51: 771-94(May 1965).

Ephestia larvae were treated with 5-bromodeoxyuridine (BDU) by injection of solutions of different concentrations 8 days after the last larval molt. Survival was high and no evidence for delay in development was found. BDU was therefore regarded as nontoxic for Ephestia. On the hind wings of treated animals, individual abnormal scales were found. They occur as single abnormal scales or as homogeneous or heterogeneous clusters. These clusters are regarded as due to the same mutational event. The number of abnormal scales per wing increased in the range from 1 to 5 μg BDU per animal. At higher levels it reached a plateau at an average of 12 mutational events on a wing containing about 6,250 scales (about 2×10^{-3}). The scale abnormalities induced by BDU differed from those induced by x rays in several ways. A lack of large clusters of aberrant scales induced by BDU may be explained by an inhibition of growth caused by the drug. The wings of animals treated with high concentrations of BDU (20 μg and over) were significantly smaller than those of controls injected with water. The induction of abnormal scales by BDU was suppressed by equimolar amounts of thymidine. The nature of the BDU-induced abnormal scales is discussed. On the basis of the evidence it is impossible to decide whether they represent point mutations, chromosome rearrangements, or genetically nontransmissible changes. The evidence seems to indicate, however, that more than one mechanism is involved. (P.C.H.)

24292 EXPERIMENTAL CONTROL OVER THE EVOLUTION OF FITNESS IN LABORATORY POPULATIONS OF DROSOPHILA PSEUDOOBSCURA. Monroe W. Strickberger (St. Louis Univ.). Genetics, 51: 795-800 (May 1965).

Four strains of Drosophila pseudoobscura isogenic for the AR third chromosome arrangement were permitted to evolve for an 18-month period under different degrees of recombination in bottles and in population cages, and under two different degrees of mutation in the cages. The competitive ability of AR chromosomes from each of these sources was then tested under population cage conditions against strains carrying the CH arrangements. For both AR from bottle and cage origins, the degree of fitness evolved was enhanced by the extent of recombination that had been experienced. At the same time, the highest competitive frequencies achieved by AR chromosomes appeared to be limited by the amount of their initial genetic variability. The mutation effect produced by 8,000 R of x rays neither enhanced nor detracted from the evolution of fitness of the AR chromosomes to which it had been added. (auth)

24293 EFFECTS OF IONIZING RADIATION ON THE BIOELECTRICAL ACTIVITY OF THE CENTRAL NERVOUS SYSTEM. H. Gangloff and T. J. Haley (Universitat, Munich and Univ. of California, Los Angeles). Intern. J. Neurol., 3: 596-617(1962).

In contrast to older morphological observations pointing to a high radioresistance of the adult central nervous system, evidence is presented to indicate that electrophysiology has been shown to be a valuable and sensitive tool for detecting bioelectrical CNS changes following radiation with doses much lower than was possible before. The results of older and recent clinical and experimental studies concerned with radiation induced changes of brain electrical and spinal cord activity are presented, including some observations on EEG changes following embryonic and early postnatal exposure. Exposure to low or moderate radiation doses may alter the central nervous system in a selective and transitory fashion and, under certain conditions, well defined subcortical structures may show electrical changes not visible with cortical surface recording. Electrical responses to lower radiation doses may not necessarily be caused by a direct effect of radiation on the area showing the changes but may be mediated indirectly by effects on structures or functions controlling the activity of the altered area. The importance of a precise topographical localization of selective radiogenic CNS alterations is stressed. Possible action mechanisms and other factors involved in electrical CNS responses to radiation are discussed. Human implications are briefly emphasized. The importance of automatic analysis for studying cortical EEG changes in man is stressed as well as the need for long range studies both in adults and in children exposed to radiation. The interest of EEG monitoring for radiotherapy, for chemical radiation protection, and for manned space flight is discussed and the mutual benefit of closer contacts between clinical and experimental neurophysiology is emphasized. As a consequence emerging from the data presented, the necessity is particularly emphasized to take into account higher CNS control with regard to its fundamental importance for any kind of radiation induced peripheral or central effect, regardless of the particular problem involved. (auth)

24294 PITUITARY SARCOMA: A POSSIBLE CONSEQUENCE OF RADIATION. Arnold H. Greenhouse (Univ. of New Mexico, Albuquerque). J. Am. Med. Assoc., 190: 269-73(Oct. 26, 1964).

An additional pituitary sarcoma occurring after x-ray treatment is described. The relation of these neoplasms to radiation is examined, and the literature on clinical and experimental pituitary radiation reviewed. The present case, that of a 31-year-old woman, who had received two courses of x-ray therapy for acromegaly, died after three attempts to remove a rapidly recurring pituitary sarcoma. At age 24 a 4000-R tissue dose with high-voltage x-ray was given to the pituitary gland. Craniotomy revealed that both optic nerves were stretched tautly over a mass which projected above the tuberculum sellae. A firm white avascular tumor was removed. Microscopically, it was composed of large, pleomorphic, generally spindle-shaped cells and indistinct cytoplasmic borders with nuclei containing many mitoses. A diagnosis of fibro-sarcoma was made. Of eight known pituitary sarcomas, seven occurred in adenomas that had been x-ray treated. Large tissue radiation doses, varying from 3940 to 11,400 R were given. Time intervals of 3 to 20 yr (average 10.4) existed between the first course of x-ray treatment and the apparent onset of the sarcoma. The normal human pituitary also tolerates large amounts of x ray without functional or histological disturbance, whereas the abnormal pituitary gland is more sensitive to radiation. Clinical evidence indicates that x-ray therapy is effective in treating pituitary adenomas. In the six patients who had also received radiation for pituitary adenoma, and developed sarcomas, large tissue x-ray doses (averaging 7220 R) were given. These cases provide strong presumptive evidence that radiation was responsible for these neoplasm. X-ray therapy is valuable in the management of pituitary tumors, but caution is advised in the use of large tissue doses. (BBB)

24295 IS THERE INCRIMINATING EVIDENCE FOR IRRADIATION LEUKEMOGENESIS? John S. Lawrence (Univ. of California, Los Angeles). J. Am. Med. Assoc., 190: 1049-54(Dec. 21, 1964).

A review is presented of evidence from diverse sources relating to the leukemogenic action of ionizing radiation. This evidence is considered particularly from the point of view of possible hazards of diagnostic irradiation. In addition, some new data are presented showing radiation doses received by patients during various x-ray and radioisotope diagnostic procedures. Irradiation over the spine and pelvis, and procedures in which fluoroscopy is used, are associated with the highest doses to the bone marrow. The small amount of irradiation resulting from a diagnostic chest film is contrasted with the much greater exposure involved in films of the spine, and, in particular, with gastrointestinal roentgenographic studies. While it is apparent that irradiation dosage of sufficient amount to produce leukemia in certain individuals can occur as a result of diagnostic procedures, this is highly unlikely if x-ray diagnostic procedures are used only when indicated. The amount of exposure resulting from the administration of radioactive substances for diagnostic procedures is very small, and no concern exists in this field at present, but as these procedures are expanded the amount of exposure may be much greater. This review led to the following conclusions: (1) The incidence of leukemia is increased by exposure to irradiation. (2) No positive statement can be made as to whether there is a threshold or linear relation between irradiation and leukemia. (3) There is no evidence that chronic lymphatic leukemia is produced by irradiation. (4) Naturally occurring radioactive substances and cosmic rays may give about 130 mRem/yr. (5) Medical irradiation results in about one-half as much bone-marrow irradiation exposure as from natural sources. (6) Variations in radiographic technique result in great differences in radiation exposure. (7) Fluoroscopy requires very careful monitoring. (8) Increased radiation exposure secondary to nuclear weapon testing is minimal. (BBB)

24296 IMPORTANCE OF ENDOGENOUS REPAIR FACTORS IN EVALUATION OF RADIOSENSITIVITY. E. Benassi and F. Piccotti (Universite, Turin). J. Belge Radiol., 47: 911-12(1964). (In French)

The effects of endogenous factors on the radiosensitivity of animals are discussed. Results are reported from studies on irradiated human cells in tissue culture and Erlich ascites tumor cells irradiated in vitro and in vivo. Tritiated thymidine was used as a tracer of nucleic acid transfer. The results confirm the hypothesis that an interaction occurs between irradiated and intact cells, possibly based on a transfer of nuclear fractions between non-irradiated to irradiated cells. (C.H.)

24297 NUCLEAR MEMBRANES OF CULTURED MAMMALIAN CELLS IN THE PERIOD PRECEDING DNA SYNTHESIS. Susumu Kishimoto and Irving Lieberman (Univ. of Pittsburgh). J. Cell Biol., 25: No. 1, Pt. 1, 103-7(Apr. 1965).

When kidney cells are cultured directly from the rabbit, the nuclear membranes undergo a change that can be measured as an increase in electrophoretic mobility. The change appears to begin immediately upon culture and is maximal 2 hours later, after which the mobility remains constant at the elevated level. Actinomycin D and p-fluorophenylalanine, but not EDTA or ionizing radiation, suppress the increase in nuclear electrophoretic mobility. With synchronously growing L cells, no change was detected in nuclei from cells taken during various parts of the division cycle. (auth)

24298 THE EFFECT OF X-RAYS ON THE FUNCTIONAL STRUCTURES OF THE Y CHROMOSOME IN SPERMATOCYTES OF DROSOPHILA HYDEI. Oswald Hess (Max-Planck-Institut fur Biologie, Tubingen, Ger.). J. Cell Biol., 25: No. 1, Pt. 1, 169-73(Apr. 1965).

X irradiation in doses as low as 1000 R caused characteristic morphological alterations in the loops of the Y chromosome in D. hydei. The alterations were reversible. However, x irradiation also caused some irreversible damage; complete or partial suppression of loop regeneration, as well as breaks within the loops. The results are not inconsistent with the suggestion that in Drosophila spermatocytes the DNA-directed synthesis of RNA can be reversibly inhibited by x irradiation. (P.C.H.)

24299 SOME EFFECTS OF GAMMA IRRADIATION ON THE GYPSY MOTH, PORTHETRIA DISPAR. P. A. Godwin, H. D. Rule, and W. E. Waters (Dept. of Agriculture, West Haven, Conn.). J. Econ. Entomol., 57: 986-90 (Dec. 1964).

Pupae and larvae of the gypsy moth, Porthetria dispar (L.), were irradiated with a cobalt-60 gamma source. The effect of various dosages on pupal survival, adult longevity, mating success, egg numbers, egg viability, and F_1 survival are reported. The irradiation of pupae more than 9 days old with 20,000 R resulted in very few crippling defects of the treated insects and reduced egg hatch to a low level. (auth)

24300 THE INITIAL SYNTHESIS OF HEMOGLOBIN IN DE-EMBRYONATED CHICK BLASTODERMS. II. THE EFFECT OF METABOLIC INHIBITORS ON THE BLASTODISC CULTURED IN VITRO. Anna Hell (Universite Libre, Brussels). J. Embryol. Exptl. Morphol., 12: 621-32(Dec. 1964).

The effects of fluorophenylalanine, bromodeoxyuridine, azaguanine, actinomycin D, and x rays on the initial synthesis of hemoglobin in the de-embryonated chick blastoderm have been studied. Morphological observations were made in sections of treated tissues. Determinations of hemoglobin, total protein, RNA, and DNA in the vascular area were made. None of these agents inhibited hemoglobin synthesis specifically. With fluorophenylalanine, x rays, and actinomycin D, the inhibition of hemoglobin production was the same whether treatment was begun at 1 or 10 somites, while with bromodeoxyuridine and azaguanine the inhibition was greater the earlier the substance was applied. Inhibition of hemoglobin, total protein, and RNA synthesis were parallel in all cases. Doses of 500, 2000, and 5000 R were tried; since 2000 R seemed qualitatively to give a slight greater effect on hemoglobin synthesis before and up to 2 to 3 somites, than at later stages, and this was chosen for further tests. X rays interfered with the vascularization of the tissue, and their effect at the cellular level was striking. The cells were of very irregular size, no normal mitotic figures were observed, and many cells had pycnotic nuclei or broken and scattered chromosomes. In the 10-somite preparation, about 5% of the cells had two to three nuclei. This did not prevent hemoglobin synthesis; in fact, the multinucleate cells were specially heavily stained with o-dianisidine. At 2000 R, the effect of x rays was constant on hemoglobin, RNA and DNA synthesis at all stages. The inhibition of total protein synthesis was slightly reduced with increasing age at irradiation. Hemoglobin synthesis continues in spite of the fragmentation of the chromosomes, the abnormal cell divisions, and barely significant DNA synthesis. The effect of the x rays on hemoglobin and RNA syntheses seems to run parallel; they are not as strongly affected as that of DNA. (BBB)

24301 EFFECT OF SPLENECTOMY AND X-IRRADIATION ON ANTIBODY FORMATION IN RETICULOENDOTHELIAL HYPERFUNCTIONAL MICE. N. R. Di Luzio, W. R. Wooles, and S. H. Morrow (Univ. of Tennessee, Memphis). J. Reticuloendothelial Soc., 1: 429-41(Dec. 1964).

Glucan-treated RE hyperfunctional mice manifested a marked increase in the primary and secondary hemolysin response. The importance of the spleen in hemolysin formation was demonstrated by the reduction of the primary and secondary immune response after splenectomy in both control and RE hyperfunctional mice. Splenectomy did not modify glucan-induced RE hyperfunction or hypertrophy. Radiation exposure produced an 80% reduction in the secondary response of glucan-treated mice when compared with the non-irradiated RE-stimulated group. The existence of a hyperphagocytic and hyperimmune state in x-irradiated RE hyperfunctional mice was indicated by a 470% increase in the secondary hemolysin response of these mice when compared with that of the saline-treated irradiated group. (auth)

24302 A STUDY OF SILK COCOONS FROM THE EGGS OF BOMBYX MORI L. IRRADIATED WITH Co^{60}. I. Molnar, A. Gubicza, and L. Babos. Magy. Textiltech., 16: 449-51 (Oct. 1964). (In Hungarian)

Eggs of Varo silkworms at various stages of their development (10 hr to the last embryonic stage) were exposed to 200 to 7000 and 100,000 R doses of ^{60}Co γ radiation. The high dose was lethal. The quality of the cocoons exposed to 200 R was nearly identical to the control group. Increased irradiation (3000 to 5000 R) brought about an increased number of deformed and dead cocoons and decreased the silk content of the cocoons and the length of the spinnable fibers; these cocoons were also smaller than the controls. The characteristics of the next generation of each subgroup will be studied. Improvements are expected in these. (OID)

24303 SUBCLINICAL RADIATION NEPHRITIS: REPORT OF A CASE. Ira N. Tublin and Ervin A. Gombos (Veterans Administration Hospital, Washington, D. C.). Med. Ann. District Columbia, 33: 552-7(Nov. 1964).

Radiation nephritis may rarely occur following exposure of the kidneys to ionizing radiation, usually administered for abdominal or testicular tumor. The fact that relatively small doses of irradiation can affect renal function has only recently been appreciated. The 32-yr-old male patient described in this report was irradiated only to an area overlying the left kidney and was studied $3\frac{1}{2}$ years after irradiation. After diagnosis of gastric lymphoma the patient was irradiated over the area of the stomach. Over a period of 103 days he received an air-skin dose of 2750 R (estimated tumor dose was 1700 R and the estimated left kidney dose between 965 and 1385 R). Because of recurring episodes of abdominal pain, the patient was readmitted to the hospital, and a review of his renal, urologic and cardiovascular systems was undertaken. Glomerular filtration rate (GFR), renal plasma flow (RPF), and solute excretion rates were diminished in the left kidney. In addition, increased Na reabsorption in the left kidney when compared to its mate was indicative of altered tubular mechanism for handling of that ion and water, resulting in significant disparity in urinary Na concentration and Na excretion fraction. Although the max urinary solute concentration was comparable in the two kidneys, tubular reabsorption of water was lower in the left kidney. Tubular reabsorption of water was impared in proportion to the diminished glomerular filtration rate. Renal biopsy showed focal nonspecific glomerular and interstitial degenerative changes, compatible with radiation injury. Thus, occasional glomeruli had somewhat thickened external capsules, showed focal clumping of endothelial cells within tufts, focal edema, and thickening of the basement membranes, and rare adhesions of tufts to the external capsules. The distal and collecting tubules contained sloughed epithelial cells and protein precipitate. The interstitial tissues and portions of the medullary tissues appeared edematous and showed moderate fibrosis and separation of existing tubules. The glomerular changes noted in the left kidney, including increased cellularity and synechiae formation, were not present in the right kidney. Values for GFT and RPF in this patient are most consistent with a process that caused loss of nephrons in the left kidney. Routine clinical tests of renal function usually fail to reflect the degree of damage due to irradiation until the functional loss is pronounced. Other clinical and experimental studies relating to radiation nephritis are reviewed. (BBB)

24304 THE INFLUENCE OF RADIUM THERAPY ON THE CONTENT OF INTESTINAL ENZYMES (ENTEROKINASE AND ALKALINE PHOSPHATASE) IN THE DUODENAL JUICE AND FECES. I. T. Abasov. Med. Radiol., 10: No. 2, 8-11(Feb. 1965). (In Russian)

In patients with carcinoma of the uterine cervix during radium therapy the author investigated intestinal enzymes (enterokinase and alkaline phosphatase) in the duodenal juice (10 persons) and feces (27 persons). The content of enterokinase and alkaline phosphatase in the duodenum commonly does not undergo any noticeable alterations. Approximately in one third of patients there was noted a moderate rise in the activity of intestinal enzymes in the feces, associated with functional or organic changes of rectum where these enzymes were destroyed. (tr-auth)

24305 ALTERATION OF THE SERUM CHOLINESTERASE ACTIVITY IN PATIENTS WITH CANCER DURING RADIUM THERAPY. N. N. Mazovka. Med. Radiol., 10: No. 2, 12-13(Feb. 1965). (In Russian)

Based on the assumption that shifts in serum cholinesterase activity may serve as an early sign of radiation injury, the author studied alterations in the cholinesterase activity in 105 patients with milk-duct and uterine cervix carcinoma of the first, second, and third stages during the process of radium therapy. The control group consisted of 32 healthy women who were only subjected to an examination. The results of the investigations, upon their comparison with clinical data, point to a reduced activity of cholinesterase occurring in patients in whom there were some marked manifestations of the radiation syndrome (an impairment of the general state, appetite, nutrition, sleep, hematopoiesis, etc.). The author points to a certain parallelism existing between the reduction of the organism's radioresistance and the activity of the serum cholinesterase. There was noted no direct relationship between the cholinesterase activity and the value of the radiation dose. During radium therapy of cancer patients investigation of the serum cholinesterase activity may be employed in some cases as an auxiliary diagnostic test. (tr-auth)

24306 THE STATE OF SERUM PROTEINS IN PATIENTS WITH MALIGNANT NEOPLASMS BEFORE AND AFTER RADIUM THERAPY. O. N. Nikonova and A. V. Popov. Med. Radiol., 10: No. 2, 13-16(Feb. 1965). (In Russian)

The changes of the blood serum protein fractions during radium treatment of patients suffering from milk-duct carcinoma, cancer of the urinary bladder, and larynx were studied by means of paper electrophoresis. Electrophoretic investigations of the blood serum were conducted throughout the course of treatment every 7 to 10 days for a period of 2 to 3 months. A total of 27 patients were examined and 680 analyses were performed. The majority of patients (24) were admitted into the hospital with a neglected stage of the disease. In all the cases prior to treatment there was seen a decreased content of albumins and an increase of the relative content of globulins, particularly alpha- and beta-fractions, and to a lesser degree gamma-globulins. During treatment the quantity of albumins continued to drop, while globulins increased. In respect to globulin fractions there was noted a two-fold and in some cases a three-fold, increase of alpha- and beta-fractions, with gamma-globulin augmented to a lesser degree. The failure of protein fractions to normalize during treatment depended on the severity of the disease and degree of recovery after treatment. (tr-auth)

24307 COMPARATIVE ASSESSMENT OF THE DOSE FIELD IN THE IRRADIATED PORTION OF THE BRAIN AND IN ITS CROSS-SECTION BY MEANS OF GEL DOSIMETRY. Ya. D. Skoropad. Med. Radiol., 10: No. 2, 23-8(Feb. 1965). (In Russian)

The paper describes the technique of gel dosimetry with trichlorethylene and purple bromcreozol during the measurement of dose fields in tissue-equivalent phantom of dog head during x irradiation. The author gives a comparative evaluation of methods of studying the field of tissue doses based on planimetric and volumetric measurement of the gel phantom. An attempt is made to explain the cause of distortion of isodoses measured in a flat gel phantom, from the viewpoint of conditions specifying the varying degree of weakening of scattered radiation during planimetric and volumetric measurement of the gel phantom. (tr-auth)

24308 FEATURES PECULIAR TO THE BIOLOGICAL ACTION OF ULTRAFRACTIONAL PULSE RADIATION. A. A. Skuratovich and G. M. Pravdina. Med. Radiol., 10: No. 2, 28-35(Feb. 1965). (In Russian)

The authors report experiments concerned with studies

of the biological action of ultrafractional radiation (four-tube x-ray apparatus with ion contactor on ignitrons). Experiments were performed on the eggs of Drosophila melanogaster. Curves of dependence of the biological effect on the dose (from 200 R to 1,200 R) were obtained. The injurious action of pulse radiations with different pulse-pause ratios is lesser than the biological effect of continuous radiation with a dose capacity of 1.3 R/sec and higher, and greater than the biological action of continuous irradiation with a dose capacity of 75 R/sec. The dose curves of pulse radiations occupy an intermediate position between the curves of continuous irradiations with dose capacities of 1.3 R/sec and 75 R/sec. The derived differences in the biological effect are explained in connection with the concept on the comparability of the total time of action and the duration of the mitotic cycle of the ovicell of Drosophila melanogaster. (tr-auth)

24309 THE INFLUENCE OF ACCLIMATIZATION TO HYPOXIA ON THE GROWTH AND RADIOSENSITIVITY OF RAT LYMPHOSARCOMA. G. A. Vasil'ev, Yu. A. Medvedev, V. B. Prozorovskii, and L. V. Melyukhina. Med. Radiol., 10: No. 2, 35-40(Feb. 1965). (In Russian)

In experiments on albino rats the authors established that preliminary acclimatization to hypoxia leads to growth inhibition of transplantable lymphosarcoma. The radioresistance of tumors in acclimatized rats decreased, whereby the radioresistance of rats in local fractional irradiation increased. The possible mechanisms governing the inhibition of growth and rise of tumor radiosensitivity in animals acclimatized to hypoxia are discussed. (tr-auth)

24310 ALTERATION OF ACQUIRED IMMUNITY IN PARATYPHOID INFECTION AT DIFFERENT PERIODS FOLLOWING IRRADIATION (EXPERIMENTAL RESEARCH). V. A. Snopkova (Karoganda Medical Inst., USSR). Med. Radiol., 10: No. 2, 51-4(Feb. 1965). (In Russian)

By using a model of paratyphoid infection in rabbits, the author assessed the effect of total irradiation on the degree of acquired immunity at different stages of radiation sickness. The animals were infected on the 4th and 12th day after irradiation. The state of immunity was evaluated by the severity of the course of infection, bacteriological, and serological indices, etc. The observations showed that the majority of immunized irradiated animals sustained a non-lethal disease; at remote periods following irradiation (on the 12th day after irradiation) the effect of immunity was more pronounced. (tr-auth)

24311 THE EFFECT OF HOMOLOGOUS GAMMA-GLOBULIN ADMINISTRATION ON THE OUTCOME OF RADIATION SICKNESS IN ANIMALS. V. F. Sosova. Med. Radiol., 10: No. 2, 54-9(Feb. 1965). (In Russian)

The administration during the first days of radiation sickness of homologous gamma-globulin, isolated from the blood serum of healthy animals (mice, rabbits) or from the blood serum of irradiated convalescents (mice), increased the survival during lethal irradiation. Thus, the expediency of studying the use of gamma-globulin in radiation sickness is demonstrated. However, intravenous administration of homologous gamma-globulin to rabbits (15 mg/kg) during the first hours after irradiation results in the development of lethal shock. Shock did not occur in mice and rats. (tr-auth)

24312 THE INFLUENCE OF ULTRAVIOLET IRRADIATION ON THE COURSE OF RADIATION SICKNESS. T. A. Sviderskaya (Leningrad Inst. of Radiation Protection). Med. Radiol., 10: No. 2, 59-66(Feb. 1965). (In Russian)

In experiments on guinea pigs the author showed that preliminary or subsequent ultraviolet irradiation modifies the organism's reaction to the effect of gamma- and x rays. The following biological indices were utilized: survival, life expectation, weight dynamics, blood morphology, and cholinesterase activity. The author assessed the optimal conditions of ultraviolet irradiation conducive to the maximal positive action of ultraviolet rays. (tr-auth)

24313 ON THE RESISTANCE OF SOME HYPHOMYCETES TO THE ACTION OF ULTRAVIOLET RAYS. N. N. Zhdanova. Mikrobiol. Zh. Akad. Nauk Ukr. RSR, 26: No. 2, 75-82(1964). (In Russian)

Prolonged irradiation with ultraviolet rays of wavelength 2537 A was carried out on 15 species of dark-coloured hyphomycetes isolated from maize rhizosphere. Six hours of action of ultraviolet rays was not lethal for 12 of the 15 species of Dematiaceae. Of them the most resistant was Stemphylium ilicis, Curvularia geniculata, Helminthosporium bondarzewi, Humicola grisea, Alternaria tenuis, Cl. transchelii and Cl. hordei. The changes obtained in the morphology of the tested species consisted, in general, of a marked lighter color of the conidia and an increase in dimensions, due particularly to elongation. (tr-auth)

24314 INFLUENCE OF ULTRAVIOLET IRRADIATION ON BACTERIA OF THE SALMONELLA GROUP. V. M. Kovbasenko. Mikrobiol. Zh. Akad. Nauk Ukr. RSR, 26: No. 3, 43-6(1964). (In Russian)

As a result of a study of the influence of ultraviolet irradiation on bacteria of the Salmonella group it was found that on repeated ultraviolet irradiation these bacteria acquire resistance to ultraviolet rays. After a successive sixfold irradiation with a IIPK-7 tube surviving Salmonella individuals of S. enteritidis, S. typhi murium, and S. cholerae suis tolerated ultraviolet irradiation for 2.5 hours. Salmonella cultures subjected to 2.5 hours of irradiation underwent thermal treatment by heating over a water bath. Bacteria S. cuteritidis, S. typhi murium, and S. cholerae suis passing through a sixfold irradiation tolerated 2 to 3 minutes of boiling, whereas unirradiated cultures were killed in 3 to 5 seconds. (tr-auth)

24315 FIELD BEHAVIOR OF SEXUALLY STERILE ANOPHELES QUADRIMACULATUS MALES. David A. Dame, Donald B. Woodard, Hugh R. Ford, and Donald E. Weidhaas (Dept. of Agriculture, Gainesville, Fla.). Mosquito News, 24: 6-14(Mar. 1964).

Males of Anopheles quadrimaculatus were sexually sterilized by three methods. In the first method, they were contact-sterilized by exposure to thio-TEPA. In the second method, males were sterilized by feeding for the first three to four days after emergence on 1% apholate in 20% honey solution. In the third method, males were radiosterilized. Pupae from 0 to 24 hr old were exposed to 12,000 R of γ radiation from a ^{60}Co source (660 r/min). After each treatment the insects were held under standard lab conditions prior to release as 1- to 4-day-old males. Through the concurrent release of sterile males and virgin females, it was shown that sterilized males of the colonized strain A. quadrimaculatus were sexually vigorous and compatible with females in nature. Thus the sterile colony males were able to induce a high degree of sterility in colony females in the field, demonstrating that mating activity of these males was not seriously affected by either radiosterilization or chemosterilization. Although the sexual vigor of the colony male may be reduced by radiation, the results showed that when sufficient numbers of either radiosterilized or chemosterilized colony males were present in a population of their own kind, they could effectively reduce the fertility of the female. Although lab-reared wild males increased the natural sterility by 480%, the inability of the colony males to induce sterility in the wild females of the natural population indicated that severe behavioral deficiencies existed in these males. These deficiences were brought on ostensibly by the colonization process. It is speculated that other species which prove particularly difficult to colonize because of flight or mating behavior may not be suitable for the sterile-male release approach to control. (BBB)

24316 EFFECT OF TEMPERATURE POST-IRRADIATION TREATMENT ON THE RADIOSENSITIVITY OF BARLEY SEEDS IN CORRELATION WITH THEIR WATER CONTENT. R. Reiter and K. Poetzl. Naturwissenschaften, 52: 107-8(1965). (In German)

In order to determine the complementary effects of temperature and water content on the degree of radiation injury, barley seeds of different water content were exposed to 30 kR γ radiation and stored at −30, 20, and 75°C. In all cases moist seeds were less injured than other seeds. Storage of normal and dry seeds at 75°C resulted in par-

tial recovery, as was true for moist seeds stored at 20 or −30°C. The data are correlated with data obtained by others. (J.S.R.)

24317 FUNCTION OF LEUCOCYTES OBSERVED IN THE BLOOD OF RADIATION TECHNICIANS. 2. CONCERNING THE APPEARANCE AND MIGRATORY VELOCITY OF STRESS LYMPHOCYTES. Keiichi Furumoto (Nippon Dental Coll., Tokyo), Eiichi Norioka, Shiro Kishinaka, and Tatsuyuki Nagai. Nippon Igaku Hoshasen Gakkai Zasshi, 21: 965-70(Jan. 1, 1962). (In Japanese)

As is known, radiation has an effect of stress upon the human body and causes an increase of so-called stress lymphocytes. This effect is detectable much earlier than the total-body reaction to irradiation appears. Radiation is genetically harmful no matter how small the dose may be; therefore, it is important to study means of early detection and measurement of the degree of radiation damage. A qualitative and functional study of blood cells was made on all radiation technicians in the Kanazawa medical school who had been employed for five to 30 yr and were selected according to the criteria set by the recommendations of the International Commission on Radiation Protection and by the table prepared by the Japanese Commission on Science and Technology Administration. Of these technicians, five were in need of close medical supervision and one of definite medical care. A control group of three healthy nonradiology technicians was also studied. Peripheral blood was examined semimonthly for six months for the occurrence of stress lymphocytes. Blood smears were prepared by the Norioka double staining method for measurement of lymphocyte index which is expressed by the percentage ratio of stress lymphocytes to normal lymphocytes. Migratory velocity of stress lymphocytes was measured by phase-microscopic examination of unstained blood specimens at 37°C according to the Sugiyama method. Leucocytes were counted and their percentage was determined. It was shown that the stress lymphocytes were found in 1 to 2% of healthy persons, while they were observed in 2 to 4% of these test technicians who were in need of medical treatment, and in 5 to 6% of those who were in need of medical observation. Increase in lymphocyte index was observed in all test technicians. The migratory velocity of stress lymphocytes was almost the same (15 μ/min) in all test and control groups, this being lower than that of normal lymphocytes. (BBB)

24318 EFFECTS OF γ IRRADIATION ON WHEAT GLUTEN. PART VI. PRONASE DIGESTIBILITY OF GLUTEN AND GLUTEN FRACTIONS OBTAINED AT VARIOUS TRICHLOROCETIC ACID CONCENTRATIONS. Masao Doguchi (Tokyo Metropolitan Hygienic Research Lab.). Nippon Nogei Kagaku Kaishi, 38: 576-9(1964). (In Japanese)

Wheat gluten samples (Vital Gluten, with H_2O content 4.5%, ash 1.79%, and protein 72.8%) were γ irradiated by ^{60}Co, various samples receiving doses of 100×10^4, 300×10^4, 600×10^4, and 1000×10^4 rep. These specimens were then analyzed for the amount of protein hydrolyzed by the enzyme pronase. Proteins in acetic acid solutions of the specimens were fractionated at various trichloroacetic acid (TCA) concentrations, and each fraction was subjected to measurement of change in protein content by the Folin copper colorimetric method and turbidimetrically (expressed in terms of the degree of absorption at 420 mμ). It was found that with an increase of radiation dose, pronase digestibility of gluten was decreased. Increasing radiation dose increased non-protein substances in the gluten. Folin chromagen per unit amount of N of these nonprotein substances also increased with the increase of dose. It was considered that these nonprotein substances differed not only from those of the nonirradiated control specimen, but also from those produced by different doses. With fractions precipitated at the concentration of 0.02M TCA, Cu-Folin color and turbidity of the TCA fractions of the irradiated specimens differed most from those of other concentrations, indicating that the acetic acid-soluble fraction of protein (mainly gliadin) was affected by the radiation, especially at dose of 600×10^4 or more. (BBB)

24319 CONTRIBUTION TO THE STUDY OF THE SO-CALLED THOROTRASTOMA OF THE NECK. C. Jemmi and C. Trombina (Arcispedale di S. Maria Nuova, Reggio Emilia, Italy). Otorinolaringol. Ital., 30: 426-40(Dec. 1961). (In Italian)

The use of thorium dioxide in contrast arteriography is considered because of the late severe complications it can produce. Experimental investigations have shown it causes degenerative lesions mainly in the hepatic parenchyma. The α-ray emissions, equal to 90% of the total Th radioactivity, are presumably responsible for the harmful effects of two commercial compounds of ThO_2 used clinically as intravenous solutions. The α radioactivity of Th inherent in the 25-ml dose used clinically is proportional to one μg of radium. The formation of a thorotrastoma in the neck in a patient 40 years old, following cerebral arteriography with Thorotrast performed 20 years before, is described. Severe neurologic and psychologic effects manifest by the tumor, were attributed to partial blockage of the carotid, thus reducing cerebral blood supply. (TCO)

24320 X-IRRADIATION AS A STRESS FACTOR IN THE PATHOGENESIS OF MYOCARDIAL NECROSES. G. S. Akhmeteli. Patol. Fiziol. i Eksperim. Terapiya, 8: No. 5, 24-7(1964). (In Russian)

For 12 days rats were subjected to a hormonal pretreatment with cortisone + Na_2HPO_4, or with cortisone + DOCA and Na_2HPO_4. Apart from this, rats of two groups were also exposed to x irradiation (450 R). The data obtained indicate that ionizing radiation may be attributed to stress factors, provoking myocardial necroses in rats pretreated through hormonal electrolyte action. (auth)

24321 PROFESSIONAL DAMAGE TO THE HAND'S SKIN IN PHYSICIANS AND MEDICAL PERSONNEL DUE TO X-RADIATION. Helena Peskova and Radko Vrabec (Charles Univ., Prague). Pracovni Lekar., 17: 93-5(Apr. 1965). (In Czech)

The clinical picture of x-ray damage to hands of physicians and medical personnel is described as well as the development of skin changes and their treatment. It is emphasized that prevention is possible only by strict compliance with all norms and instructions, by improvement of the professional skill of those working with radiation and by technical excellence of the equipment. (P.C.H.)

24322 THE EFFECT OF X-RADIATION ON THE ELIMINATION OF SOLID PARTICLES FROM THE LUNGS Juraj Ferin, Gertruda Urbankova, and Angelika Vlckova (Inst. of Experimental Medicine, Czechoslovak Academy of Sciences, Bratislave). Pracovni Lekar., 17: 105-6(Apr. 1965). (In Czech)

The effects of x radiation (300 R) on elimination of solid particles from the lungs was studied in rats (Albino Wistar). Out of the original deposit of 558 μg SiO_2 for a brown rat, 42.3% were eliminated in the course of 26 days. Animals irradiated two days prior to inhalation were able to eliminate 37.2%, those with one day's interval 20.5%, and animals irradiated on the day of exposure were able to eliminate only 17.4%. The doses used in the experiment inhibited the elimination in relation to the interval between radiation and exposure. The fall of white blood cells had no relation to the diminished capacity of the eliminating mechanism; this is further evidence for the conception that pulmonary macrophages and not the blood cells prevail in the alveolar phagocytosis. (auth)

24323 SOME RADIATION EFFECTS ON DNA AND ITS CONSTITUENTS. Walter Gordy, Brenda Pruden, and Wallace Snipes (Duke Univ., Durham, N. C.). Proc. Natl. Acad. Sci. U. S., 53: 751-6(Apr. 1965).

The results of an ESR study of gamma-irradiated DNA are presented, from which it was concluded that the thymidine-like resonance is formed by a hydrogen-addition reaction. An interpretation of ESR curves obtained elsewhere for gamma-irradiated samples of guanylic acid and desoxyadenosine is proposed. (D.C.W.)

24324 REPAIR OF X-RAY DAMAGE IN MICROCOCCUS RADIODURANS. B. E. B. Moseley and H. Laser

(Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. B, 162: 210-22(Apr. 13, 1965).

Micrococcus radiodurans, a red-pigmented bacterium, is very resistant both to x and to ultra-violet radiations. The dose-response curves in both cases are sigmoidal with high extrapolation numbers. Two non-pigmented mutants of M. radiodurans have been isolated. One of these shows the same type of survival curve as the wild type while the other has an exponential survival curve. Energy transfer reactions including the possible role of pigment have been excluded as a mechanism of resistance. Similarly, resistance is not due to unusual amounts or unique properties of the bacterial DNA. Survivors of both sensitive and resistant bacteria show a lag period following irradiation. In the case of sensitive bacteria no change occurs in the radiosensitivity of the cells during this period. On the other hand, M. radiodurans recovers during the lag period, at the end of which it has become as resistant as the unirradiated cells. All available evidence for the loss of viability in bacteria points to DNA as the target. Recovery of M. radiodurans from radiation damage, therefore, is concluded to be due to repair of damaged DNA by an active cellular, probably enzymic process which occurs during the lag period. The large shoulder of the survival curve and the high extrapolation number are a reflexion of the efficiency of the repair system. The significance of the sigmoidal and exponential survival curves of resistant bacteria is discussed and a theory put forward which postulates two types of damage to the genetic structures, each having a specific repair system. Some experimental evidence in support of this theory is produced. (auth)

24325 NATURAL AND RADIATION CARCINOGENESIS IN MAN. I. THEORY OF INITIATION PHASE. P. R. J. Burch (Medical Research Council, [Leeds, Eng.] and Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. B, 162: 223-39(Apr. 13, 1965).

A review is given of the evidence and arguments supporting the hypothesis that carcinogenesis is a multi-stage process. In addition to the broad distinction between initiation and promotion phases, it is highly probable that initiation itself is multi-stage in character. Previous models of the initiation phase are briefly described; they do not resolve the question as to how many stages are involved. A factor common to all these models, and to the new one described here, is that, other things being equal, cancer incidence should be related to the number of cells at risk. This prediction receives some support from human epidemiological statistics, and from murine experimental evidence. The new model is based on the traditional assumption that each stage of the initiation process is marked by some form of somatic mutation, most probably of nuclear genes. It is constructed to permit the analysis of events throughout the life span and not merely during adult life. Equations are derived in which the average somatic mutation frequency appears as a function of the number of somatic mutations needed to initiate any particular stage, at any given age from fertilization. Familial and other evidence shows that certain individuals, comprising a subpopulation, may have a predisposition (usually genetically-based) to a particular malignancy or group of malignancies. The effect of this population heterogeneity on mortality statistics is analysed mathematically. (auth)

24326 NATURAL AND RADIATION CARCINOGENESIS IN MAN. III. RADIATION CARCINOGENESIS. P. R. J. Burch (Medical Research Council,[Leeds, Eng.] and Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. B, 162: 263-87(Apr. 13, 1965).

The application of an hypothesis of spontaneous carcinogenesis to the phenomenon of radiation carcinogenesis is described. Equations connecting the carcinogenic response to acute and chronic irradiations are derived. The effects in genetic-carriers and in noncarriers require separate consideration and further distinction is necessary between the short- and long-term responses. It is shown that the cytotoxic effects of ionizing radiation have to be allowed for when the short-term response to an acute irradiation is assessed, although they may generally be ignored when estimating the long-term response. However, the long-term response in a carrier subpopulation will be complicated by the magnitude of the short-term effect. The influence of age is discussed and is shown to be complicated, especially in genetic carriers. The more reliable data for radiation carcinogenesis and leukemogenesis in man are used in conjunction with the hypothesis to calculate the ratio of the radiogenic to the spontaneous mutation coefficient. The values that emerge are reasonably consistent with one another and with the independent experimental evidence relating to the radiomutability of genes in germ and somatic cells of mice. (auth)

24327 RADIATION SENSITIVITY OF SACCHAROMYCES CEREVISIAE IN RELATION TO INDUCED FORMATION OF INTRACELLULAR CATALASE. G. B. Nadkarni, R. Jayaraman, V. R. Naik, L. D. Deshpande, and M. V. Divekar (Atomic Energy Establishment, Trombay, India). Radiation Botany, 5: 75-80(May 1965).

Catalase activity of Saccharomyces cerevisiae increases as a function of dose of γ-irradiation. This has been observed along with an exponential fall in the survival of the cells. Evidence has been presented to show that radiation induced increase in the enzyme activity was due to de novo enzyme formation. Radiation survival of the yeast cells could be modified by preinducing different levels of intracellular catalase, increase in survival being proportional to the preinduced level of the enzyme. In spite of dependence of the radiation sensitivity on the intracellular catalase activities, it was observed that post-irradiation increase in the enzyme activity did not contribute towards counteracting the damage caused to the ability of the cells to form colonies. Metabolic implications of these observations have been discussed in relation to the processes of cell division and enzyme formation. (auth)

24328 THE FATE OF METAPHASE ABERRATIONS. Alan D. Conger (Univ. of Florida, Gainesville). Radiation Botany, 5: 81-96(May 1965).

Dose curves for metaphase exchanges and anaphase bridges, and also of exchanges that separate in the fall-free (no bridge is formed) or interlocked (bridge-producing) manner at separation stage (very earliest anaphase), were observed in Tradescantia. A constant fraction, 47 per cent independent of dose, of metaphase exchanges separate in the fall-free manner, 53 per cent separate to make bridges. But of the bridges formed at separation, a fraction, increasing exponentially with dose, rupture at early anaphase and thus escape detection as anaphase bridges in the usual scoring procedure. About 19 per cent of the bridges rupture at 100 R, and this fraction increases exponentially to about 72 per cent at 400 R. A model is proposed to explain rupture of bridges in anaphase, based on the number of restituted breaks (or potential or partial breaks), proportional to dose, in a bridge. It is assumed a restituted break (or potential or partial break) constitutes a weak spot in the chromosome that has the possibility, P_b, of rupturing under tension in an anaphase bridge. A bridge containing n such restituted breaks in it (n proportional to dose) has a probability of rupture, $P_r = 1 - (1 - P_b)^n$; thus the probability of rupture increases exponentially from zero at zero dose to 1.0 large dose. The model predicts that at very high dose (at very high restituted break frequencies) observed anaphase bridges should fall to zero, and that with linear-with-dose exchange ancestors — as are formed with high LET radiations — anaphase bridges, as observed, should increase less rapidly than linear with dose. The model also predicts that the curve for anaphase bridges vs. dose should increase (not necessarily linearly) with dose, pass through a maximum and fall toward zero at higher doses. A large fraction, 33 per cent, of all rings separate to form a large single (dicentric) ring at anaphase. Obtaining the large ring at anaphase is most likely if the G_1 chromosome is single stranded and non polarized, less if functionally double-stranded and non polarized, and least likely if both two-stranded and polarized. Furthermore, the two-stranded polarized condition would produce particular configurational types at separation which are not observed. It is calculated that scoring of abnormal anaphases, cells with bridges, de-

tects roughly 20 per cent of the chromosomal damage actually produced and analyzable at metaphase. This value is not constant, being more at low dose, less at higher doses. (TCO)

24329 EFFECTS OF GAMMA IRRADIATION ON GLADIOLUS. M. Buiatti, R. Ragazzini, and F. Tognoni (Univ. of Pisa, Italy). Radiation Botany, 5: 97-8(May 1965).

Dormant corms of the gladiolus varieties Opera and Bird of Downing, were irradiated with ^{60}Co gamma rays (15,000, 20,000 and 25,000 R). Irradiation clearly reduced percentage of surviving plants and number of flowers per spike in both varieties; however, the negative effect of irradiation was much stronger in the variety Opera. In this variety, three cases of change in flower color (from red to pale pink) were observed in a total of 61 surviving plants. (auth)

24330 GAMMA-RAY INDUCED CHANGES IN THE CARNATION, DIANTHUS CARYOPHYLLUS L. M. Buiatti and R. Ragazzini (Univ. of Pisa, Italy). Radiation Botany, 5: 99-105(May 1965).

Research was carried out on the induction by gamma rays of somatic mutations in carnation (varieties: Cardinal Sim and Elia Rosso), with particular reference to the behavior of induced chimerical situations. A significant physiological effect was observed as shown by the decreased number of flowers per branch and branches per plant. This effect was less pronounced on the first emerged branch than on the lateral emerged branches. Chlorophyll deficient sectors occurred in frequencies roughly proportional to dose. Four types of induced color changes were recorded in one variety (Elia Rosso) and one in the other (Cardinal Sim). Their frequency was sufficiently low to support the idea that both varieties are not periclinal chimaeras. The frequency of color changes was higher in the three branches which emerged first than in their laterals; it was also higher in the first-emerged branch than in the second and third ones. From an analysis of mutated areas in single sectorial petals, it was calculated that at least 50 cells may be involved in the ontogeny of one petal at the stage when irradiated. The analysis of the number of petals did not show any significant effect of the treatment on means, but revealed an increase in variability roughly proportional to dose. This could support the idea that the number of petals is controlled by a polygenic system. From a study of the distribution of waxless areas in R_1 plants, it was concluded that cellular populations still maintain their genetic heterogeneity (chimeric condition) in tertiary branches. (auth)

24331 RADIATION EFFECTS ON DEVELOPING OVULARY TISSUE IN ORCHIDS. Altha J. Brown and Yoneo Sagawa (Univ. of Florida, Gainesville). Radiation Botany, 5: 107-8(May 1965). (TID-21635)

Orchid ovularies present a system useful for studies, previously lacking, of radiation effects on megasporogenesis. Initial investigations reveal a differential sensitivity of cells. Degeneration of nucellar epidermal cells and chromosome aberrations are prevalent; meiotic delay of the megaspore mother cell occurs. Occasional degeneration of a nucellar row promontory is present in tissue not visibly affected otherwise. (auth)

24332 EFFECTS ON MEDICAGO SATIVA L. OF ACUTE DOSES OF GAMMA RADIATION. P. Manil and P. Demalsy (Institut Agronomique de l'Etat, Gembloux, Belg.). Radiation Botany, 5: 109-14(May 1965). (In French)

Aseptic plantlets of Lucerne (Medicago sativa L.) growing in test tubes on agar medium were submitted to single acute doses (2000, 4000 and 6000 rad) of gamma radiation. According to the series of plantlets, the radiation treatments were made at different times, and the observations were taken during a long vegetative period. The following points were considered: the effects of irradiation on the growth of the plants (aerial part and root system); the effects on the physiological condition of the plantlets; and the effects on the number and characteristics of nodules induced by Rhizobium meliloti. The most important observations are summarized in two tables. (auth)

24333 RESPIRATION AND PHOTOSYNTHESIS OF CHLORELLA UNDER CHRONIC γ IRRADIATION. F. Koessler (Institut fur Arbeitsphysiologie des Deutschen Zentralinstituts fur Arveitsmedizin, Berlin). Radiation Botany, 5: 115-28(May 1965). (In German)

Respiration and photosynthesis of a thermophilic strain of Chlorella pyrenoidosa were studied in a closed circuit gasflow system by means of CO_2-analysis (infra-red absorption spectrometer). CO_2-exchange in constant darkness and with intermittent light exposures remained constant for 10 days, provided experimental conditions were kept constant. Chronic exposures to 40 R/hr from a ^{137}Cs source caused a depression of respiration after 5 to 6 days in constant darkness. This depression ranged from 30 to 50% of the initial value. With intermittent light exposures such radiation exposures neither influenced endogenous respiration nor photosynthesis. Decreased respiration caused by gamma-irradiation in constant darkness could be restored by light exposures, varying light intensities always giving the initial value. This photorestoration after damaging the system by gamma-rays was also attained, if photosynthesis was blocked by complete removal of CO_2. The effect can be explained as photoreactivation after incidence of ionizing radiation. When the system was irradiated for comparison with acute doses of very high dose rate (^{60}Co, 1000 R/min), high radiation resistance was observed. No depression of respiration was to be seen, and doses above 100 kR gave an increased CO_2-release. Rate of photosynthesis was not changed even by doses as high as 960 kR. No differences to control cells were observed in growth tests after chronic exposures (5000 R). After acute exposures an extension of the lag-phase was seen for 20 kR, the latter being strongly extended for higher doses. Chronic and acute exposures gave different results, which points to different reaction mechanisms. The high sensitivity of Chlorella to chronic exposures may be explained by suggesting that in its metabolism under starvation a radiation sensitive reaction exists, which lies before the respiratory chain and is influenced by low doses of irradiation. (auth)

24334 EFFECTS OF GAMMA IRRADIATION ON GROWTH, COLONY-FORMING ABILITY AND SOME CELLULAR CONSTITUENTS OF CHLORELLA PYRENOIDOSA. Herbert B. Posner (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 5: 129-41(May 1965). (BNL-8535)

Cells of Chlorella pyrenoidosa grown for 3 days under gamma radiation (7200 R/day) multiplied exponentially but at a rate one-half that of controls. Colony-forming ability, declined exponentially during the 3-day period. When irradiation was discontinued on day 2, colony-producers multiplied at a rate higher than that of controls. Cultures in which such recovery had occurred showed an increase in the proportion of small cells. The postirradiation multiplication rate of colony-producers after an equivalent acute exposure was lower than controls. It is suggested that partial synchronization of survivors occurred during the 3-day irradiation. Survivors of the continuous irradiation were given various acute exposures. The resulting survival curve had a reduced shoulder when compared with a survival curve for cells not preirradiated. Cells exposed for 3 days (7200 R/day) increased in volume and had increased amounts of DNA and protein, but not of RNA. When the concentration of these substances was calculated as amount per cubic micron of cell, controls and irradiated cells did not differ with respect to DNA or protein; however, RNA concentration of irradiated cells was lower than that of controls. Radiation-induced loss in colony-forming ability of Chlorella appears to be more closely associated with reduced concentrations of RNA than of DNA or protein. (auth)

24335 THE RADIATION SENSITIVITY OF DIFFERENT DEVELOPMENT STAGES OF TETRAPLOIDE OENOTHERA BERTERIANA. Rudolf Seufert (Universitat, Erlangen-Nuremberg). Radiation Botany, 5: 153-69(May 1965). (In German)

Radiosensitivity was studied in ^{60}Co irradiated Oenothera berteriana. Although presoaked seeds showed a higher percentage of germination than seeds air-dried prior to irradiation, plants from dry irradiated seeds had higher survival rates. Tetraploid plants were more radioresistant than diploid ones. Egg cells were more radiosensitive than zygotes, which in turn were more sensitive than pollen grains. Doses necessary for killing shoot tips in the Rosetten stage were determined. (H.G.D.)

24336 EFFECTS OF RADIATIONS ON MERISTEMATIC CELLS. H. J. Evans (Medical Research Council, Harwell, Berks, Eng.). Radiation Botany, 5: 171-82(May 1965).

Three main types of cytological change are observed in irradiated plant meristem cells. These are: mitotic cycle delay; formation of chromosome aberrations; and loss of proliferative capacity due either to premature differentiation or cell death. The importance of these three changes in contributing towards the growth reduction in x-irradiated primary root meristems of Vicia faba is discussed. The data indicate that mitotic delay plays but a minor role in contributing to growth depression, and that the importance of chromosome aberrations in contributing to this effect may be rather less than has generally been assumed. Experiments on roots exposed to a lethal dose (1600 rads) of x rays reveal that the majority of cells develop through the G_1 and S phases of interphase but rarely enter mitosis, so that death of cells in these roots occurs in late interphase. It is suggested that this type of effect leading to premature differentiation or death of cells in late interphase may be a major contributory factor to growth reduction induced by exposure to sublethal radiation doses. (auth)

24337 FOUR-FACTOR MODEL ANALYSIS OF THYMIDINE INCORPORATION INTO MOUSE DNA AND THE MECHANISM OF RADIATION EFFECTS. P. A. Stewart, H. Quastler, M. R. Skougaard, D. R. Wimber, M. F. Wolfsberg, C. A. Perrotta, B. Ferbel, and M. Carlough (Brookhaven National Lab., Upton, N. Y.). Radiation Res., 24: 521-37(Apr. 1965).

The previously proposed four-factor model for DNA synthesis was elaborated for the specific case of thymidine incorporation into mouse nuclei and analyzed by analog computer simulation. The model predicts a depression of labeled thymidine uptake by exogenous nonlabeled thymidine and also provides an approach to the analysis of radiation effects on label incorporation. Autoradiograph grain count data from squash preparations of several mouse tissues, after a variety of thymidine doses and x-ray treatments, are in qualitative agreement with the predictions of the model. Several factors involved in the scatter of grain count data are outlined. Analysis of radiation effects in terms of the model parameters tentatively suggests that irradiation depresses labeled thymidine uptake in intestinal crypt cells by increasing the effective triphosphate pool size. (auth)

24338 EXPERIMENTAL PULMONARY THROMBOEMBOLI IN RATS AFTER THORACIC X-IRRADIATION. Charles E. Tobin (Univ. of Rochester, N. Y.). Radiation Res., 24: 538-46(Apr. 1965).

The thorax of mature male and female white rats was x irradiated with 500 to 3600 R, while the animals were anesthetized, and shielded over the upper and lower parts of the body by lead, ¼ inch thick. Both small multiple and single large doses of x irradiation were used. The injection of blood clots, labeled with ^{131}I fibrinogen to facilitate their detection, was made into the jugular vein to produce pulmonic thromboemboli. The injected clots did not reduce the survival time of the animals, which previously were exposed to varying doses of x irradiation. Calcification of the pulmonary artery was observed at the branching of the artery and corresponded to the usual point of impaction of the clots. X irradiation apparently hastened the formation of the calcified plaques. The clots did not produce infarction of the lungs, although a prolonged lysis time for the clots was related to the extent of radiation damage in the pulmonary artery. (auth)

24339 RBE AND QUALITY OF ELECTROMAGNETIC RADIATION AT DEPTHS IN A WATER PHANTOM. Jack S. Krǫhmer (Univ. of Texas, Dallas). Radiation Res., 24: 547-62(Apr. 1965).

Measurements of radiation quality in terms of effective photon energy in kiloelectron volts were made by using a steel-tissue dual ionization chamber. These measurements compare to within 10% of values obtained by others using dual chambers and scintillation spectrometers. It was concluded that dual chamber readings provide simple meaningful specifications of radiation quality for biological investigations. HeLa cells in tissue culture, irradiated in plastic test tubes in suspension, proved to be a suitable biological indicator for determining RBE of radiation beams degraded by passage through scattering materials. The median lethal dose for parental strain HeLa cells was found to be 159 ± 13 Rads; for S-3 strain the value was 138 ± 12 Rads. The difference between these values was very significant (P less than 0.001). No difference in biological effectiveness with depth was found. This included cobalt-60 and the four x-ray modalities tested (P = 0.5 to 0.6). No difference in biological effectiveness was found for any modality of x rays tested (P = 0.5 to 0.6). The relative biological effectiveness for cobalt-60 radiation with respect to any of the modalities of x rays was found to be: $RBE_{Co} = 0.90 \pm 0.02$ at 95% confidence level. This value with its associated standard error compares favorably with values previously reported for cobalt-60. P = 0.01 for the difference between cobalt-60 and x-ray MLD's. (auth)

24340 THE EFFECT OF RADIATIONS ON REPLICATION IN BRACHIOMONAS SUBMARINA BOHLIN. H. S. Ducoff, Barbara D. Butler, and Elaine J. Geffon (Univ. of Illinois, Urbana). Radiation Res., 24: 563-71(Apr. 1965). (COO-878-11)

Brachiomonas submarina was grown under conditions of continuous illumination, so that population growth was exponential, or with alternating light and dark periods, so that replication, or the formation and release of new daughter cells, was confined to a 3- or 4-hour period beginning about 6 hours after the start of the dark period. X irradiation, even in doses permitting less than 10% survival, produced no suppression of replication for at least 30 hours. Germicidal ultraviolet irradiation caused an immediate, although temporary, suppression of replication in exponentially growing cultures. In cultures maintained under cycled illumination, ultraviolet irradiation almost completely eliminated the next population increase unless irradiation was performed less than 2 hours before release of the new cells, and even then markedly reduced the magnitude of the population increase. (auth)

24341 LONG-LIVED ELECTRON SPIN RESONANCES IN RATS IRRADIATED AT ROOM TEMPERATURE. Harold M. Swartz (Walter Reed Army Inst. of Research, Washington, D. C.). Radiation Res., 24: 579-86(Apr. 1965).

The prolonged existence of radioinduced unpaired electron species in the femurs of living rats was demonstrated by ESR techniques. The findings appear to have significance in both radiobiological theory and dosimetry of radiation accidents. (auth)

24342 EARLY ELECTROCORTICAL EFFECTS OF UNILATERAL AND BILATERAL CRANIAL X-IRRADIATION IN THE ALBINO RAT. Alan Glass (Univ. of Birmingham, Eng.). Radiation Res., 24: 587-600(Apr. 1965).

Early electrocorticographic (E.Co.G.) changes after cranial x irradiation with 4300 R were studied in rats under tribromoethanol anesthesia by intercomparison of the E.Co.G. frequency spectra from both hemispheres after bilateral and left and right unilateral cranial x irradiation, with the effects of control procedures. After bilateral irradiation, the E.Co.G. showed a statistically significant increase in slow waves in categories I and II (0.33 to 1.0 second and 0.33 to 0.50 second in duration, respectively) from both hemispheres, but after left and right cranial irradiation a significant increase in waves in categories I and II occurred on the shielded side. Bilateral cranial irradiation thus induced an expected change in the E.Co.G. frequency spectrum, but the cause of the contralateral E.Co.G. changes after unilateral cranial x irradiation was not as obvious. It was concluded that the most probable

explanation is that, by a direct volume stimulus of the x irradiated hemisphere, the E.Co.G. of the nonirradiated hemisphere is influenced, possibly through commissural fibers, in a manner similar to that which has been described in peripheral nerve experiments. (auth)

24343 A PARADOXICAL EFFECT OF DOSE RATE IN PARTIAL-BODY IRRADIATION. Samuel Hellman (Yale Univ., New Haven). Radiation Res., 24: 601-11(Apr. 1965).

Two groups of mice were irradiated to the upper body with the same total dose but with different durations of radiation exposure. The leukopenia produced was greater and significantly more prolonged in the group irradiated over the longer duration. This finding is consistent with the hypothesis that the leukopenia produced by localized radiation is due to destruction of circulating stem cells. Mortality, weight loss, and hair graying showed the expected dose-rate effect, with the high-intensity short-duration being more effective. (auth)

24344 RADIATION RESPONSE OF POTASSIUM EFFLUX IN MICROCOCCUS RADIODURANS AND SARCINA LUTEA. T. P. Merrick and A. K. Bruce (State Univ. of New York, Buffalo). Radiation Res., 24: 612-18(Apr. 1965).

The responses of potassium efflux to irradiation of S. lutea and M. radiodurans were found to be exponential at lower doses and level off at higher doses. Micrococcus radiodurans exhibited a doubling of its potassium efflux rate at about 300 kR, a dose nearly identical with its LD_{50}. Sarcina lutea exhibited a doubling of efflux at 50 kR and an LD_{50} of 45 kR. The radioresistance of the cell surface of M. radiodurans may be influenced by the radioprotective agent present in the cell (5,6), although the equally high radioresistance of the cell surface of E. coli B/r (4) makes its probable contribution small. (auth)

24345 EFFECT OF WHOLE-BODY IRRADIATION ON THE ACTIVITY OF ACID DEOXYRIBONUCLEASE OF MOUSE TISSUES. Olga Pierucci and William Regelson (Roswell Park Memorial Inst., Buffalo). Radiation Res., 24: 619-30(Apr. 1965).

A net increase in total organ activity of acid deoxyribonuclease was demonstrated in spleen and thymus of Ha/ICR Swiss mice exposed to sublethal doses of whole-body irradiation. A similar increase was also found when involution of lymphoid tissues resulted from treatment with agents other than radiation. The increase could not be explained by release of enzyme from damaged lysosomes nor by the presence of dissociable inhibitors or activators. Stimulation of the adrenal pituitary axis did not seem to account for the effect of radiation. The increase of the activity of the enzyme under study appeared to be directly related to the destruction of lymphoid tissues. (auth)

24346 EFFECTS OF IONIZING RADIATION ON RATES OF CO_2 EXCHANGE OF PINE SEEDLINGS. E. B. Hadley and G. M. Woodwell (Brookhaven National Lab., Upton, N. Y.). Radiation Res., 24: 650-6(Apr. 1965). (BNL-8414)

Acute exposures to as little as 1250 R of ionizing radiation alter the patterns of CO_2 exchange in seedlings of Pinus taeda and P. elliottii. The long-term effects of acute exposures include depression of rates of net photosynthesis and depression of rates of CO_2 evolution by stems. Acute irradiation did not affect the rate of dark CO_2 evolution by pine leaves, even after 13,200 R at 8000 R/hr. Rates of CO_2 evolution of leaves of seedlings exposed to 1250 R at 50 R/hr increased by 23 to 36%, an observation substantiating previous field studies. (auth)

24347 RADIORESISTANCE OF LYMPHOCYTES INCUBATED AT LOW TEMPERATURES. Robert Schrek and Lloyd M. Elrod (Veterans Administration Hospital, Hines, Ill.). Radiation Res., 24: 657-66(Apr. 1965).

Suspensions of rat and human lymphocytes were irradiated with 10 to 1000 R of x rays and incubated at 15 to 42°C for 1 and 7 days. The number of viable lymphocytes was counted before and after incubation. Incubation at low temperatures inhibited the development of the cytotoxic effects of x rays. Temperatures that protected the lymphocytes against the effects of x rays were 15, 18, and 22°C for rat lymphocytes and 22 and 27°C for human cells. Incubation at 15 and 18°C was cytotoxic to human but not to rat lymphocytes. (auth)

24348 THE INDUCTION OF THYMINE DIMERS IN ULTRAVIOLET-IRRADIATED MAMMALIAN CELLS. J. E. Trosko, E. H. Y. Chu, and W. L. Carrier (Oak Ridge National Lab., Tenn.). Radiation Res., 24: 667-72(Apr. 1965).

Thymine dimers were induced by ultraviolet irradiation in the chromosomal DNA of Chinese hamster cells in vitro. Within the range of incident dose tested, the amount of dimers increased linearly with dose. Neither photoreactivation nor excision of the induced dimers was detected. (auth)

24349 EFFECTS OF IONIZING RADIATION ON THE HEME-PROTEIN BOND IN SOME HEMOPROTEINS. V. P. Komov and S. E. Manoilov (Leningrad Chemical-Pharmaceutical Inst. and Central Scientific-Research Inst. of Roentgen-Radiology, Leningrad). Radiobiologiya, 5: 166-8(1965). (In Russian)

The action of penetrating radiation caused labilization or breaking of the bonds between heme and protein in catalase and hemoglobin. Catalase was more radiosensitive than hemoglobin, apparently because of the different types of bonds between heme and protein in these hemoproteins. (tr-auth)

24350 RADIATION DAMAGE TO ERYTHROCYTES SUSPENDED IN NATIVE AND PROTEIN-FREE MEDIA AND EXPOSED TO VARIOUS TYPES OF RADIATION. K. S. Trincher, A. M. Kuzin, Yu. I. Bregadze, and E. I. Gintsburg (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 174-8(1965). (In Russian)

The relative biological effectiveness of 5-kRad doses of fast neutrons, compared to gamma rays, was about 1.3 for erythrocytes suspended in physiological saline and about 3.5 for them in blood. The RBE's of hard x rays were about 1.3 and about 1.2 respectively. The protective effects of extra-cellular proteins on erythrocytes was greater for gamma and hard x rays than for fast neutrons. When erythrocytes were x or gamma irradiated in physiological saline, an indirect action, through the extracellular water radicals, predominated. With neutron irradiation the action was directly on the cellular structures, as was also the case for irradiation of erythrocytes in blood. (tr-auth)

24351 EFFECTS OF ^{90}Sr ON THE DESOXYRIBONUCLEASE ACTIVITY IN RAT URINE. M. S. Uspenskaya. Radiobiologiya, 5: 179-82(1965). (In Russian)

Subcutaneous administration of ^{90}Sr to rats (4, 2, and 1.5 μC per kilogram of body weight) significantly increased the DNAase II in the urine as radiation sickness progressed. The degree of kidney damage depended directly on the ^{90}Sr dose. The urine DNAase increased within a day after a 4-μC/kg dose and was maximum (175%) on the sixth day. With a 2-μC/kg dose, the increase was observed on the third day and was maximum (70%) on the seventh day. With a 1.5-μC/kg dose the increase was observed also on the third day, and was maximum (66%) on the ninth day. (tr-auth)

24352 CHANGES IN CONCENTRATION OF NUCLEIC ACIDS IN THE HYPOPHYSIS TISSUE IN WHITE RATS EXPOSED TO BREMSSTRAHLUNG RADIATION FROM LINEAR ACCELERATOR WITH COMPLEX SPECTRUM. I. N. Todorov (Scientific-Research Inst. of Medical Radiology, Khar'kov). Radiobiologiya, 5: 186-9(1965). (In Russian)

Nucleic acid concentrations in the pituitary gland of male white rats subjected to 600 and 1240 R of bremsstrahlung from a complex-spectrum linear accelerator were compared with control values. The differences observed were interpreted as due to increased pituitary function resulting from irradiation damage. Data from 825-R doses, which were investigated only perfunctorily, were similar. (IIC-M.G.)

24353 RESPONSES OF SPONGES AND COELENTERATES TO β RADIATION. G. P. Korotkova and B. P. Tokin (Leningrad State Univ.). Radiobiologiya, 5: 190-7 (1965). (In Russian)

The calcareous sponges Leucosolenia complicata and L. variabilis given 25, 50, or 100 kR of beta radiation (^{90}Sr–^{90}Y) were still living 15 to 17 days later. After 50- or 100-kR doses, the sponges regenerated deficient portions of the tube walls 2–3 days later than controls. Morphogenesis was similar in irradiated and control organisms, as was phagocytic activity. The lower Coelenterate species differed in their radiation resistance. A 450-R dose did not kill Laomedea flexuosa or Coryne loveni but was lethal for Clava multicornis. Beta irradiation in a wide range of doses causing disintegration of the cell system may induce somatic embryogenesis processes (development of whole organisms from somatic cells) and suppress natural regeneration (regeneration by the organism of lost parts). Doses from 25 to 200 kR did not affect the phagocytic activity of the cells in irradiated nontraumatized Laomedea colonies. In Clava multicornis irradiation and traumatization combined caused more active phagocytosis. (tr-auth)

24354 ON THE RESTORATION OF HEMOPOIESIS IN DOGS FOLLOWING CHRONIC γ IRRADIATION AND INJECTION OF ^{90}Sr. M. F. Aleksandrova and V. S. Kushneva. Radiobiologiya, 5: 202-6(1965). (In Russian)

Prolonged exposure of small external doses of gamma radiation or internal ^{90}Sr on dogs depressed hemopoiesis, decreasing the erythroblasts and granulocytes in the bone marrow 40–60%. Leuko- and thrombopenia developed in the peripheral blood. The depression in hemopoiesis at a given degree of damage reached a limit slowly and a year after the effect stopped the bone marrow and peripheral blood were only partially back to normal. The period of depressed hemopoiesis was characterized by activation of erythropoietic processes, which increased the erythroblastic cells in the bone marrow. Depression of granulopoiesis began with acceleration of maturation processes in the white cells, which led to partial normalization of the state of the peripheral blood in the absence of changes in the granulocyte content of the marrow. Prolonged gamma irradiation or introduction of ^{90}Sr in equivalent doses caused different hemopoietic reactions not only during development of the damage but also during recovery. Administration of liver extract and blood-letting changed the hemopoietic state drastically. (tr-auth)

24355 ELECTROPHORETIC CHANGES IN MALIGNANT NEOPLASIA AS A BIOLOGIC INDEX OF RADIOSENSITIVITY. I. Ciampelli (Universita, Florence). Radiol. Med., 47: 542-53(June 1961). (In Italian)

Variations in serum γ-globulin fractions were observed in patients receiving ^{60}Co teletherapy in total focal doses of 4000 to 6000 R administered either as initial tumor treatment or following radical surgery and in patients receiving 800 to 2000 R of x radiation for various nonmalignant diseases. No variations in serum γ-globulin fractions were noted in the latter group. Increases of γ-globulin fractions in the first groups were attributed either to a general reticuloendothelial system reaction to topic products freed by tumor destruction or to the proliferation of mesenchymal cells progressively replacing neoplastic tissue, as well as to possible formation of antibodies to the denatured proteins freed by the effects of radiotherapy on the tumor. (H.S.D.)

24356 COMBINED EFFECT OF UV-RAYS AND CYANAMIDE ON THE GERMINATION OF FUNGAL CONIDIA. Nicola Loprieno and Onorato Verona (Universita, Pisa, Italy). Ric. Sic., Rend., Ser. B, (2), 5: 65-70(Oct. 1964). (In Italian)

The influence of cyanamide on the lethal effect of UV-radiations was tested in fungal conidia. The results show that the compound increases the fungicidal effect of UV on two fungi tests, and that the lethal effect of UV increases with the dose of the cyanamide. (tr-auth)

24357 INFLUENCE OF PHYSIOLOGICAL CONDITIONS OF CELLS ON REPAIR OF SUBLETHAL DAMAGE INDUCED BY X-RAYS IN DIPLOID YEAST. Silvia Bacchetti and Francesco Mauro (Universita, Rome and CNR, Rome). Ric. Sci., Rend., Ser. B, (2), 5: 91-2(Oct. 1964). (In Italian)

Results are reported from irradiation experiments on diploid yeast cells to investigate the characteristics of repair of sublethal damage induced by x rays. The radiation dose was delivered in two equal fractions split by a period of time during which the cells were stored in growth medium at 27°C. The results showed that the repair phenomenon occurs in diploid yeast cells if irradiated when grown in lag phase and starved. The first radiation dose was delivered to resting cells showing the same constant radiosensitivity during the interval between the fractions of dose. Moreover, the cells were relatively synchronized in respect to the first divisions occurring after the end of the repair process. Further experiments, performed on cells growing in log phase and unstarved, confirmed the occurrence of the repair phenomenon in diploid yeast. However, they have revealed the existence of a different kinetics of the repair depending upon the different physiological conditions used through the experiments (lag/log growth phase, starvation or not, and consequently synchrony or not). The observed decrease of survival during the repair process could be explained with a synchronization induced by the first x ray dose, probably producing accumulation of cells in a more radiosensitive stage. (tr-auth)

24358 THE EFFECT OF IRRADIATION WITH X- OR γ-RAYS ON THE SYNTHESIS OF RIBONUCLEIC ACID AND ON THE TYROSINE-α-KETOGLUTARATE ACTIVITY OF RAT LIVER. Ottavio Barnabei, Anna Mazzone, and Giovanni Rava (Universita, Bari, Italy and Ospedale Miulli, Bari, Italy). Ric. Sci., Rend., Ser. B (2), 5: 179-84(Dec. 1964). (In Italian)

In rats irradiated with x rays, cortisone caused a higher increase in RNA synthesis and a lower increase in tyrosine-transaminase activity than in controls. In animals irradiated with γ rays (^{60}Co), cortisone produced an increase in tyrosine-transaminase as in the controls, but stimulated to a much higher extent the synthesis of RNA. (P.C.H.)

24359 COSMIC RADIATION AND TUBERCULOSIS. III. INFLUENCE OF COSMIC RADIATION ON TUBERCULOSIS AT HIGH ALTITUDE AND AT SEA-LEVEL. S. G. Ong (Inst. of Epidemiology, Academy of Medical Sciences, Peking). Sci. Sinica (Peking), 11: 645-76(May 1962).

In order to ascertain the differential action of cosmic radiation and barometric pressure on tuberculosis, experiments have been performed at Kunming, China (altitude 1897 m) and at the same time at Peking (52 m). Mice of an inbred strain were injected intravenously with tubercle bacilli and maintained under identical conditions in the two locations. Several groups were kept under lead shields of different thicknesses. Tuberculous mice exposed to direct cosmic radiation at the high altitude showed a highly significant greater mean survival time than that of tuberculous mice kept at sea-level. That this is due to the higher intensity of low-energy particles of cosmic radiation at high altitude was suggested from the fact that after absorption of the low energy particles with 1, 2, or 10 cm Pb, no significant difference in mean survival time was observed among mice at high altitude and at sea-level. Statistical analysis on more than 16,000 patients treated in sanatoria at high altitude (1560 m) and at sea-level or medium altitude shows the benefit of tuberculosis treatment at high altitude; highly significant lower mortality and highly significant greater mean survival time were seen. The significantly greater mean survival time and significantly lower mortality of mice kept under 1 cm Pb at sea-level suggest that these are due to the photon-electron showers. The significant increase in mean survival time and significantly lower mortality of mice kept unshielded on the ground floor of the lab at sea-level and of mice kept unshielded in a tunnel at high altitude (1897 m) suggest that these are due to the presence of natural radioactivity. At sea-level the female mice showed a significantly greater mean survival time and a significantly lower mortality than the males. At

high altitude (1897 m) no significant difference in mean survival time was observed between males and females, but the males and females did not have the same mortality in each of the five treatments. (BBB)

24360 ELECTROPHORETIC INVESTIGATION OF THE LIVER PROTEINS OF IRRADIATED ANIMALS. A. M. Makhlina and G. N. Abusina. Vestn. Leningr. Univ., Ser. Biol., No. 21, 89-100 (1961). (In Russian)

With the help of the method of paper electrophoresis it was shown that the norm and after the general effect of ionizing radiation of rabbits at the dose of 4000 R and rats at the dose of 1200 to 2000 R it is possible to separate the soluble liver proteins into 10 protein fractions. A considerable decrease of proteins of all the liver-protein fractions takes place under radiation, on an average 30 per cent in experiments with rats and 18 per cent in experiments with rabbits. A considerable decrease of albumins, β_1^-, μ, and γ-globulins and an increase of α- and β_2-globulins in the serum of blood was observed. Concurrently with the quantitative changes of the protein an increase of electrophoretic mobility of the liver protein fractions and of the serum of blood of the radiated animals was observed. The decrease of the general level of the protein, is related to the breach of its normal synthesis under the condition of radiation. (tr-auth)

24361 INFLUENCE OF X-RAY IRRADIATION ON THE RATE OF THE RENEWAL OF LIPIDS AND CHOLESTEROL IN THE LIVER OF WHITE RATS. M. F. Vinogradova. Vestn. Leningr. Univ., Ser. Biol., No. 3, 102-13(1962). (In Russian)

The rate of the renewal of total lipids and cholesterol in the liver of x irradiated rats (doses of 400, 800, 1200 R) was studied with the help of ^{14}C-labeled acetic acid. The results of the investigations showed that the rate of the renewal of total lipids and cholesterol depended upon the dose of irradiation and the phase of the radiation sickness. The 400 R irradiation caused the intensification of the rate of the renewal of cholesterol in 24 hours and that of the total lipids of the liver in 6 hours after the irradiation. However, the intensification was not long and undulatingly reduced on the next days. The maximal intensification of the rate of the renewal of cholesterol and total lipids of the liver after 800 R irradiation took place in 24 hours after the irradiation. Then the rate of the renewal of cholesterol was relatively reduced, but still remained over the control data. During next 3 to 5 days the rate of the renewal of total lipids was reduced, and on the 7th day it was again at its highest. The intensification of the rate of the renewal of cholesterol and total lipids after the 1200 R irradiation was observed only in 48 hours. (tr-auth)

24362 EFFECTS OF DIFFERENT DOSES OF X-RAY IRRADIATION ON CHANGES OF INTRA-CELLULAR RESTING POTENTIALS OF MUSCULAR FIBRES. M. I. Sologub. Vestn. Leningr. Univ., Ser. Biol., No. 15, 138-45(1962). (In Russian)

The effect of roentgen irradiation on the resting potentials (RP) recorded with intra-cellular microelectrodes in the fibers of sartorius muscle of Rana temporaria was studied. Irradiation by doses 300, 1400, and 6400 R influenced slightly the structures and mechanisms that generated the RP. It was observed that the two-phase changes of the RP after 1400 R irradiation first increased and decreased the resting potential. The effect of all other doses was a one-phase decrease of the RP. The facts are discussed as corroboration of unspecific parabiotic changes of the cells effected by the Roentgen irradiation. (tr-auth)

24363 DEPENDENCE OF THE LEVEL OF ACQUIRED IMMUNITY IN RATS ON THE DOSE OF IRRADIATED NIPPOSTRONGYLUS BRASILIENSIS LARVAE. Zdenek Prochazka and William Mulligan (Glasgow Univ.). Vet. Med. (Prague), 9: 457-60(Dec. 1964).

The immunogenic effect was studied by comparing normal larvae to those treated with 100kR of x rays. Under experimental conditions a dose of 2,000 larvae was required to develop marked immunity. Differences found in degree of inactivation by identical doses of x ray were due to differences in the radiosensitivity of the larvae. (CFSTI)

24364 CONCENTRATION OF THE GLYCOLYSIS INTERMEDIATES, DIPHOSPHOPYRIDINE NUCLEOTIDE, ADENOSINE TRIPHOSPHATE, PYRUVIC ACID, AND INORGANIC PHOSPHATE IN IRRADIATED TUMOR CELLS AFTER ADDITION OF PYRUVIC ACID. H. Maass, W. Schmack, and S. Opuku (Universitat, Hamburg). Z. Krebsforsch., 65: 261-71(Mar. 20, 1963). (In German)

Cells of the Yoshida ascites tumor, suspended in Ringer: carbonate solution were irradiated at room temperature with 25000 R of 200-kv x ray at a dose rate of 1064R/min. Immediately thereafter the cells were incubated anaerobically for 1 hr with and without pyruvic acid added at a concentration of 5×10^{-4} M. In the cells irradiated without added pyruvic acid, glycolysis was decreased initially by 65% compared to controls, but after 40 or 50 min it reached almost normal values. This was accompanied by increased concentrations of cytoplasmic diphosphopyridine nucleotide. Pyruvate concentrations remained almost constant in the samples not supplemented with pyruvic acid, but increased considerably after pyruvate was added initially. This increase was paralleled by a lower, but increasing concentration of lactate. The concentrations of lactate were about 25% less in the irradiated samples. When compared for the early portion of the incubation period to unirradiated samples, and without added pyruvate, concentrations of adenosine triphosphate were decreased ~ 40% in irradiated samples. This difference decreased to about 15% by the end of 1 hr. However, in irradiated samples to which pyruvate had been added, there was no significant change in adenosine triphosphate concentration. Inorganic phosphate concentrations were not markedly affected by either irradiation or addition of pyruvate. The authors conclude that the increase in diphosphopyridine nucleotide was sufficient to accelerate dehydrogenation of the triose phosphate. (BBB)

24365 PHOTOREACTIVATION OF UV DAMAGE IN PHAGE CONTAINING 5-BROMOURACIL DNA. Gerhart Hotz (Kernforschungszentrum, Karlsruhe, Ger.). Z. Vererbungslehre, 95: 211-14(1964).

It was previously shown that photoreactivation (PHR) and host-cell reactivation (HCR) are blocked in uv-damaged phage heavily substituted with 5-bromouracil (BU). The reactivable sector decreases and uv sensitivity increases with increasing amounts of incorporated BU. This study deals with the uv-protective action of cysteamine on phage T1, the DNA of which has been heavily substituted by BU, and with the influence of this substitution on photoreactivation of the phage. The results of comparative experiments with normal and substituted BU T1 suspended in buffer and uv irradiated in the presence and absence of cysteamine showed that the sensitizing effect due to BU incorporation is observed when phage are plated in the dark on a bacterium lacking HCR. Although the difference in final slope of the dose-survival curves of normal and BU-substituted phage is small, a complete elimination of the initial shoulder is found with BU T1. This can not be due to an effect of residual HCR-ability in Escherichia coli strain used (B_{S-1}), since the two curves are identical to those obtained after adsorption on heavily uv-irradiated E. coli B. PHR is reduced to a small sector in BU T1, probably due to incomplete substitution. The presence of 0.01M cysteamine during irradiation does not alter the survival rate of normal phage; however, it eliminates effectively the radiosensitization in BU phage. PHR is nearly normal if the substituted T1 phage is irradiated in the presence of 0.01M cysteamine. These results of protection against uv damage due to BU incorporation indicate that photoproducts of uv damage in halogen-base substituted phage differ qualitatively from those produced in ordinary uv damage, otherwise uv-irradiated normal phage would also be protected by cysteamine. Such protection, however, was not observed in these experiments. The conclusions concerning SH protection against uv damage in BU DNA are that SH compounds prevent some secondary chemical reactions resulting in a completely altered DNA structure which can not be restituted by the host cell. Results of other studies suggest that one of the main functions of cysteamine is restriction

of the BU damage to the strand containing the particular BU residue hit by the photon. Two alternative explanations are given for the observation that both HCR and PHR occur in BU phage in a normal amount when irradiation is done in the presence of cysteamine: (1) Intrastrand thymine dimers are a specific substrate for reactivating enzymes, but the photoproducts of BU formed in the presence of SH compounds are removed or split off by these enzymes with the same efficiency. (2) Reactivation mechanisms of radiation damage are rather unspecific. The most likely mechanism by which recovery processes can handle photoproducts of thymine as well as photoproducts of BU, irradiated in the presence of cysteamine, would be excision of an oligonucleotide containing the radiation lesion. (BBB)

24366 THE BIOLOGICAL EFFECTS OF IONIZING RADIATION ON HUMANS. J. Spaander (Rijks Instituut voor de Volksgezondheid, Utrecht). p.5-31 of "Symposium Gezondheidsaspecten bij Radioactive Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

A bibliographic review is made of the studies of the biological effects of ionizing radiation on humans. The factors affecting the biological aspects, the principal radiation units, and the protection standards are discussed. (J.S.R.)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 24542.

24367 (EUR-2151.f) ETUDE EXPERIMENTAL DE L'ACTION DE LA PADUTINE DANS LE TRAITEMENT DES RADIODERMITES ET DES RADIONECROSES. (Experimental Study on the Use of Padutin in the Treatment of Radiodermititis and of Radionecroses). P. Mandel, C. Gary, F. Imbaud, and J. Rodesch (Strasbourg Univ. (France)). 1965. 66p. Dep.(mn)

Doses of x rays in excess of 50,000 rem induce in rats serious radiolesions which persist for over four months. Treatment with Padutin, which is applied from the third week after irradiation, i.e. at the ulceration stage, results in total cicatrization after twelve weeks' treatment. Doses of less than 50,000 rem almost invariably induce lesions which heal spontaneously, but treatment with Padutin results in faster and earlier cicatrization. Recurrences are much less frequent in the treated animals. Premature treatment, e.g., at the stage of erythema or vesicular radiodermititis, aggravates the inflammatory processes and delays cicatrization. Biochemical determinations of the nucleic acids and collagen, as well as the mitotic index, appear to be valuable means of assessing this treatment, from both the qualitative and quantitative viewpoint of the cicatrization phenomenon in radionecroses during treatment with Padutin. (tr-auth)

24368 REPAIR REPLICATION OF DNA IN BACTERIA: IRRELEVANCE OF CHEMICAL NATURE OF BASE DEFECT. Philip C. Hanawalt (Stanford Univ., Calif.) and Robert H. Haynes. Biochem. Biophys. Res. Commun., 19: 462-7(May 3, 1965).

Evidence was found to indicate that a non-conservative mode of DNA replication follows treatment of uv-resistant bacteria with HN2. This implies that a general biochemical mechanism exists for the repair of a variety of DNA structural defects. The thymine-requiring E. coli strain TAUbar was used. (P.C.H.)

24369 PROTECTION AGAINST DEPILATION BY CYSTAMINE AFTER LOCAL IRRADIATION IN THE CASE OF RATS. P. van Caneghem (Université, Liège). Experientia, 20: 699-700(Dec. 15, 1964). (In French)

The extent of the radioprotection, in time dependence, in local x irradiation, on the hair growth was investigated in cystamine-injected (i.p.) rats. The maximum radioprotection was found after 10 min. It decreased slowly after that and was still detectable 60 min after cystamine injection. (tr-auth)

24370 RADIOPROTECTORS AND CANCERS. J. R. Maisin, J. Hugon, and A. Leonard (Centre de l'Energie Nucleaire, Mol, Belg.). J. Belge Radiol., 47: 871-85 (1964). (In French)

Aminoethylisothiuronium (AET) was shown to penetrate normal and cancerous tissues of mice with ease and without distinction. Results indicate that during the first hour after the administration of AET the incorporation of ^{3}H-thymidine into the DNA of the crypt cells of the small intestine was depressed. Within a few minutes following the administration of AET mitochondrial lesions were observed which were attributed to damage of the succinic dehydrogenase and cytochrome oxidase systems. From 10 to 30% of the mice, protected by the combined administration of AET, gluthatione, and serotonin, prior to the exposure to an x ray dose of 2000 R were still alive after 30 days. Even though AET afforded the same protection against radiation damage to cancer and normal tissues, it was possible, under special experimental conditions, to prolong greatly the survival of mice implanted with Landschütz ascites cells by administering AET prior to x irradiation. (tr-auth)

24371 BONE MARROW AND SPLEEN CELL HOMOTRANSPLANTATION IN DOGS FOLLOWING CHEMOTHERAPY AND TOTAL BODY IRRADIATION. M. Myron Kauffman, Richard F. Clark, and David M. Hume (Medical Coll. of Virginia, Richmond). J. Surg. Res., 5: 2-10(Jan. 1965).

Bone marrow and/or spleen cell transplants were performed in 71 dogs receiving whole body irradiation either alone or in combination with immunosuppressive drug therapy. Five animals survived by virtue of either successful autologous bone marrow or spleen cell transplants. Two animals, who were irradiated in the lethal dose range (540 and 600 R) and whose marrow homograft failed to take, survived by regeneration of their own marrow. The importance of intensive supportive care, including frequent fresh whold blood transfusions, is described. Temporary homologous bone marrow transplants were obtained in one animal following 1200 R alone; in one animal following 6-MP and 700 R; and in three animals following 6-MP and 900 R total body radiation. No permanent marrow takes were obtained and each of these animals died of grafted marrow rejection. Differences in the radiosensitivity of cells responsible for homograft immunity and ease of transplantation of bone marrow in the rodent, as compared to the dog, are discussed. Because the dog rejects homografted tissues following lethal (600 to 1000 R) doses of total body radiation, it is felt that transfusion of fresh blood containing viable leukocytes has no harmful effects, and evidence is presented that fresh whole blood, under these circumstances, is beneficial. (auth)

24372 PRELIMINARY RESULTS IN THE TREATMENT AND PROTECTION AGAINST CORPOREAL IRRADIATION WITH THE USE OF A PREPARATION OBTAINED FROM BOVINE SPLEEN. G. Reggiani, M. Scursatone, and G. Pipino (Universita, Genoa). Minerva Med., 52: 2451-3 (July 11, 1961). (In Italian)

Adult rats and guinea pigs were treated with lyophilized spleen before or after they received whole-body irradiation with 800-R doses of 180-kv x rays. The control irradiated animals showed a maximum survival period of 12 days. All animals received the spleen preparation via intraperitoneal injections. In the guinea pigs, the best results were observed in the animals treated with five mg of spleen two hr and one hr before irradiation and five mg daily for four days after irradiation, or were treated after irradiation for five days with five mg of lyophilized spleen. In the rats, the best results were observed in the animals which received a single injection of 30 mg of spleen after the irradiation. In the guinea pigs, the maximum survival period observed was 25 days, and in the rats, 20 days. It is emphasized that the protective action is greater if the lyophilized preparation is injected after irradiation. In the rat, whole-body irradiation causes increased cellular acid deoxyribonuclease activity in the spleen, and simultaneously

a decrease of the serum alkaline deoxyribonuclease inhibitor is observed in spleen homogenate. It is suggested that the lyophilized spleen preparation acts primarily on the radiation-caused cell damage. (TCO)

24373 CHEMICAL PROTECTION OF MEG AGAINST IONIZING RADIATION. REPORT IV. COMPARATIVE PROTECTIVE EFFECTS OF MEG AGAINST FAST-NEUTRON AND X-RAY IRRADIATION IN MICE. Shigetoshi Antoku (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 935-40(Nov. 25, 1963).

The protective effects of MEG were studied with regard to responses of the hematopoietic system, such as bone marrow cell counts, spleen weight, thymus weight, and ^{59}Fe uptake in mice exposed to 180-kvp x rays and 14.1-Mev neutrons. The dose was 200 rad of total-body irradiation with both radiations. Female mice (ddN strain), 7 to 8 weeks old, were used. MEG was prepared by dissolving AET in distilled water and neutralizing with NaOH to pH 7.2; 200 mg/kg of freshly prepared MEG was injected intraperitoneally 5 min before irradiation. Bone marrow counts, spleen weight, and thymus weight in both MEG-protected and unprotected groups showed the lowest values on the 3rd day after irradiation. They showed a tendency to recovery on the 6th day and reached normal values on the 10th day. In the protected group the depression of all responses was less severe and recovery was earlier. The protective effect of MEG was more significant in mice exposed to x ray than those exposed to neutrons. The protective effect of MEG on ^{59}Fe uptake in hematopoietic system was most marked on the third day after irradiation. It was concluded that though MEG had protective activity against injuries caused by neutron irradiation, it was less effective against injuries caused by neutron than against those caused by x ray. In general, gastrointestinal injury is more marked in animals exposed to fast neutrons within the $LD_{50(30)}$ range as compared with x and γ rays. Most of the radioprotective agents are considerably less effective in protecting the intestinal epithelium than the hematopoietic system. Therefore, protective agents are probably less effective against radiations which cause more damage to the intestinal system than the hematopoietic system. If the poor effectiveness of protective agents against neutron irradiation is due to the small dose reduction factor for intestinal injuries, protective agents should be effective for hematopoietic injuries in neutron irradiated mice. However, in this study MEG modified hematopoietic injuries, as seen by bone marrow cell counts and ^{59}Fe uptake, in neutron-irradiated mice less effectively than in x-irradiated mice. Therefore, the poor effectiveness of MEG against neutrons was not due to the small dose reduction factor for intestinal injuries. This is taken as evidence that MEG brings about a general reduction in the effective neutron dose rather than selective protection of specific physiological system. (BBB)

24374 EXPERIMENTS ON THE PREVENTION OF EXCESSIVE POSTRADIATION REACTION IN THE X-RAY TREATMENT OF THE LARYNGEAL CARCINOMA. Waclaw Kusnierczyk, Anna Wieczorkiewicz, and Janina Vorbrodt (Inst. of Oncology, Kliwice, Poland). Nowotwory, 13: 341-5(Oct.-Dec. 1963). (In Polish)

Methods were sought, particularly by the use of antibiotics, to reduce the side-effects of radiation. These clinical experiments were conducted in 109 patients with laryngeal carcinoma treated by a conventional x irradiation method. Doses of 100 to 150 R of 180-kv x rays were given until total doses of 5000 to 5500 R had been received. The patients were divided into three groups according to sequence of admission. The first group was treated by x rays without any protection, the second group received penicillin and streptomycin (Tarchocillin) during x-ray treatment, and the third group received in addition, prednisone (Encorton) therapy. The early radiation reaction was divided into three stages according to the intensity of reaction. The differences in intensity of the early reactions of the groups receiving antibiotic protection and in the control group were not statistically significant. Further observations on the same groups of patients are in progress as to the frequency and intensity of late post-radiation complications. (BBB)

24375 MODIFICATION OF X-IRRADIATION LETHALITY IN MICE BY MICROWAVES (RADAR). R. A. E. Thomson, S. M. Michaelson, and J. W. Howland (Univ. of Rochester, N. Y.). Radiation Res., 24: 631-5(Apr. 1965).

Pretreatment of mice with microwaves altered the lethal response to x radiation. Mean survival time of microwave-treated animals given ionizing radiation was longer than that for animals not subjected to microwaves. Alteration of response to ionizing radiation injury by microwave treatment has now been observed in three species of experimental animals — dogs, rats, and mice. (auth)

24376 STUDIES ON THE RADIOPROTECTIVE ACTION OF SODIUM NITRITE IN MICE. Andrew T. Hasegawa and H. D. Landahl (Univ. of Chicago). Radiation Res., 24: 636-49(Apr. 1965).

The environmental temperature at which mice were kept after the injection of 200 mg of nitrite per kilogram was an important factor affecting death times. Mice kept at 32°C died earlier than those kept at 25°C, whereas those kept at 18°C lived the longest. Sodium nitrite administered intraperitoneally to mice at a dose of 150 or 200 mg/kg reduced the oxygen tension in the spleen to 42 and 22% of normal, respectively, in 21 minutes. Intravenous injection of methylene blue was used to prevent death, thus permitting the administration of a lethal dose of nitrite. Methemoglobin concentration and nitrite levels in the blood, plasma, and spleen measured at different times for 21 minutes after injection of sodium nitrite (200 mg/kg) showed that both levels increased with time. Injection of sodium nitrite (200 mg/kg) 20 minutes before x-ray exposure afforded protection against radiation lethality, the ratio of the LD_{50} to that of the control mice being 2.35. When the interval between nitrite injection and x irradiation was 7 or 15 minutes, the protection was less than at 20 minutes. This decrease in protection can be correlated with the observation that the value of the oxygen tension at 7 or 15 minutes was not so low as at 20 minutes. Protection after nitrite was also reduced when the mice were irradiated at 1 atm of oxygen, and it was almost completely eliminated when the animals were irradiated at 4 atm of oxygen. It was found that the dose-reduction factors in all the situations could be calculated in a simple way from a knowledge of tissue oxygen tension and the nitrite dose. (P.C.H.)

24377 SOME PHARMACOLOGICAL MECHANISMS AND THE INTERRELATIONSHIP OF BULBOCAPNINE AND 5-HYDROXYTRYPTAMINE ON THE CARDIOVASCULAR SYSTEM OF THE DOG. Taghi Fakouhi. Thesis, Corvallia, Ore., Oregon State Univ., 1964. 105p.

The intrinsic activities of 5-hydroxytryptamine (5-HT) and bulbocapnine and their interaction in regard to blood pressure and contractile force in the dog were studied. A number of drugs and procedures were used to evaluate these responses. The effects of intravenous injections of 5-HT on the blood pressure and contractile force were found to be of a pressor nature. Bulbocapnine caused a fall of both the blood pressure and contractile force and some changes in electrocardiogram and potassium levels of serum and heart tissue. This agent inhibited the pressor actions of 5-HT and partially reduced the responses of tested catecholamines. The possible mechanisms for inhibition were sought. Chronic bulbocapnine treatment of dogs led to marked potentiation of 5-HT responses. The experiments with rats, chronically treated with bulbocapnine, failed to show any changes in the survival time when the animals were subjected to x irradiation. (Dissertation Abstr., 25: No. 6, Dec. 1964).

Radiation Hazards and Protection

See also HEALTH AND SAFETY.

24378 (UWFL-88) RADIONUCLIDE CONTENT OF OCEANIC FISH, PLANKTON, AND WATER IN THE VICINITY OF CHRISTMAS ISLAND, MARCH THROUGH AUGUST

1962. Arthur D. Welander and Ralph F. Palumbo (Washington Univ., Seattle. Lab. of Radiation Biology). Sept. 4, 1963. Contract AT(45-1)-1385. 50p. Dep.; $2.00(cy), 1(mn) CFSTI.

Four oceanic surveys within 600 miles of Christmas Island were made, March through August, 1962, prior to, during and after the Dominic test series to determine the radionuclide content in pelagic fish, plankton, and sea water. Analyses of 107 yellowfin tuna and 62 other species of pelagic fishes showed that during this period there was little change, if any, in levels of radioactivity in samples of light muscle, dark muscle, and liver tissue. More of the liver samples were radioactive and the liver tissue contained a greater number of radionuclides than the muscle tissue, but the amount of any one radionuclide in a sample was the same for all tissues. The levels of radioactivity of these radionuclides averaged less than the potassium-40 content of the tissues and in most cases were barely detectable. Plankton samples collected during the latter part of the operation contained slightly higher levels of radioactivity, especially zirconium–niobium-95 and cerium-141, 144, as well as a greater variety of radionuclides. It appears that measureable, but very low levels, of comparatively short-lived radionuclides in the plankton were due to fallout from the tests at Christmas Island. Analysis of sea water samples revealed no increase in either the number of radionuclides present in each sample or in the levels of radioactivity during the period of study. (auth)

24379 ZASHCHITNAYA TEKHNIKA. SPRAVOCHNIK-KATALOG. TOM I. OBORUDOVANIE. (Radiation Protection Techniques. Handbook-Catalog. Vol. I. Equipment). Moscow, State Committee on the Utilization of Nuclear Energy, 1964. 82p.

The handbook-catalog includes basic radiation protection equipment and techniques used in handling radioactive and toxic materials. Design and specifications are given for boxes, fume hoods, laboratory furniture, manipulation tables, screens, safes, remote control manipulators, and transportation internal and external containers. (R.V.J.)

Radiotherapy and Radiodiagnosis

Refer also to abstract 24858.

24380 (EUR-1889.f) UTILISATION DU KRYPTON 85 SOUS FORME DISSOUTE DANS L'ETUDE DES SHUNTS PULMONAIRES ET BRONCHIQUES. (Use of Dissolved Kr-85 in the Study of Pulmonary and Bronchial Shunts). H. Cleempoel, P. Mercenier, F. Colin, G. de Castro, F. Kornreich, M. Kornitzer, and J. Lequime (Brussels Univ. (Belgium) and Pisa Univ. (Italy)). 1964. 6p. (CONF-640808-1). Dep.(mn)

From European Congress on Cardiology, Prague.

The simultaneous injection of ^{85}Kr and a non-diffusible indicator as reference, is a simple, precise, and innocuous method, which appears specific for the diagnosis and the quantitative evaluation of venoarterial shunts. Serial injections performed during catheterization provide informations in order to localize exactly abnormal communications including arteriovenous pulmonary shunts. This method is very useful in this clinical condition, especially when diffuse shunts are concerned. Further, the use of ^{85}Kr seems a good approach to the study of some physiopathological conditions, probably associated with the opening of pulmonary shunts, frequently described by the anatomists and whose functional reality never has been demonstrated. Abnormal data observed on pentobarbital-anesthetised dogs may be explained by the aforementioned hypothesis. An experimental method for the determination of arterial bronchopulmonary shunts by means of ^{85}Kr has been achieved and studied in dogs and men. The first results are reported. (tr-auth)

24381 (UCLA-12-523) EXPERIMENTAL BASIS OF QUANTITATIVE RADIORENOGRAPHY FOR EVALUATING RENAL ISCHEMIA. Earl K. Dore, G. V. Taplin, D. E. Johnson, and A. T. Cockett (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology and Harbor General Hospital, Torrance, Calif.). May 1964. Contract AT(04-1)-Gen-12. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A quantitative expression of the slopes of the sodium ortho-iodohippurate-^{131}I renogram's second segments is shown experimentally to be a reliable measure of fractional renal blood flow. Most patients with unilateral renal artery occlusive disease and hypertension have blood flow values to the involved kidney which are clearly below the normal range. A critical degree of renal artery constriction must be exceeded before blood flow falls or renogram abnormalities appear. When renal artery constrictive diseases is bilateral, fractional flow to each kidney may be normal even though both kidneys are definitely ischemic. To quantitate ischemia a separate estimate of total flow is required. Radioassay of the renogram test agent (iodohippurate ^{131}I) in the urine collected exactly 15 minutes after injection is a simple way to obtain this information. (auth)

24382 (UCRL-11978) RADIOISOTOPE CAMERAS. Hal O. Anger (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1965. Contract W-7405-eng-48. 114p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The advantages of radioisotope cameras (nonscanning devices for imaging the distribution of radioisotopes in vivo) over scanners are outlined. The various instruments and methods used to image the radioisotopes are reviewed briefly, and the scintillation camera is described in detail. Image-producing collimators for use with γ-ray emitters are considered. Positron coincidence collimation is also considered along with recording methods. (D.L.C.)

24383 (UCRL-Trans-1205(L)) THE CLEARANCE OF COLLOIDAL RADIOGOLD (^{198}Au). I. NORMAL AND PATHOLOGICAL VALUES. R. Fauvert, J.-P. Benhamou, S. Nicollo, and A. Loverdo. Translated by Z. St.-Gallay (Univ. of California Lawrence Radiation Lab., Livermore), from Rev. Franc. Etudes Clin. Biol., 3: 763-7(1958). 20p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The clearance of colloidal ^{198}Au by hepatic reticuloendothelial cells was studied in 22 normal subjects and patients with a variety of pathological conditions including cirrhosis, cancer of the liver, obstructive jaundice, acute hepatitis, cardiac insufficiency, and myeloid leukemia. Approximately 100 to 200 μg of colloidal ^{198}Au, corresponding to an activity of about 100 μC was injected intravenously and blood samples were withdrawn from the arm at 4 min intervals, normally for a period of 16 min. The activity of the blood samples was measured by means of a scintillation counter. Changes in the clearance of colloidal ^{198}Au by the liver were observed in some of the pathological conditions but not in others. It was concluded that the changes were associated with changes in hepatic blood flow or in the efficiency of purification of the liver. The phagocytic activity of the liver appeared to be only slightly affected by the pathological conditions studied. (C.H.)

24384 NEOHYDRIN LABELLED WITH RADIOACTIVE MERCURY IN THE DIAGNOSIS OF INTRACRANIAL NEOPLASMS. J. Kaplan. Ann. Radiol., 8: R76-85(1965). (In French)

Emphasizing the need for rapid information in the diagnosis of intracranial neoplasms, the author used neohydrin labeled with Hg-203 for this purpose. This has the advantage of supplying information on the topography, and sometimes on the nature, of these processes 3 hours after injection of 1.000 μC instead of after 24 or 48 hours. Examples are given. Irradiation delivered to the kidneys proves not to be negligible (440 R for 1000 μC). It is therefore recommended to use neohydrin labeled with Hg-197, which has the advantages of a shorter period, dose delivered to the kidneys 100 times smaller, no beta irradiation, and similar curves. (tr-auth)

24385 INFLUENCE OF THE POSITION OF THE X-RAY TUBE ON THE GONAD DOSE AND RADIATION SCAT-

TERING. W. Herstel. Ann. Radiol., 8: R87-91(1965). (In French)

By means of phantom measurements the gonadal dose and the stray radiation were determined in the case of irradiation of the thorax and the abdomen. From the point of view of reduction of the gonadal dose, dorsal irradiation is preferable. (tr-auth)

24386 RADIOTHERAPY OF LESIONS OF THE LIDS. Milford D. Schulz and Chiu-chen Wang (Massachusetts General Hospital, Boston). Intern. Opthalmol. Clin., 4: 239-53(Mar. 1964).

Radiosensitivity of various structures in and around the the eye is considered in relation to radiation doses required to treat different diseases in this zone. Complications of irradiation of the eye are also considered. (TCO)

24387 THE USEFULNESS OF BRAIN SCANNING. Stanley E. Sneider and Donald M. Dooley (Univ. of Miami, Fla.). J. Am. Med. Assoc., 190: 1012-14(Dec. 14, 1964).

Brain scanning using chlormerodrin-^{203}Hg was shown to be a useful aid in the evaluation of the patients with suspected intracranial disease. Given intravenously, about half of the dose is excreted in eight hours. It accumulates in many intracranial tumors, cerebral infarctions, and vascular lesions, apparently as the result of the breakdown of the blood brain barrier. The ^{203}Hg disintegrates with γ emission of 0.28 Mev and it has a physical half-life of 45.8 days which allows satisfactory shelf storage even if a large case load is not present. Adult patients for brain scanning are given 2 ml of Na meralluride intramuscularly the night before the examination; children are given 1 ml. This injection blocks kidney uptake of the chlormerodrin-^{203}Hg. The kidney radiation exposure from a 700-μC dose of chlormerodrin ^{203}Hg is reduced from about 40 rad without sodium meralluride to about 12 rad when sodium meralluride is used. The chlormerodrin-^{203}Hg dose is 10 μC/kg of body weight in adults and 15 μC/kg in children. Two to three hours following the intravenous administration of this drug, the brain scan is started and usually requires about 1 to 1$^1/_2$ hr to complete. The patient's head is scanned across the anterior or posterior aspect. A commercial scanner is used with a 19-hole collimator. The scan speed is 30 cm/sec, the time constant is 0.4 sec., and the suppression varies between 40% and 60%. Of 64 patients scanned in this manner over a period of five months, seven patients showed discrete, abnormal areas of isotopic concentration, from 2 to 8 cm in dia. All seven were subsequently shown to have primary brain tumors. Patients with other types of intracranial disease were also encountered. An extradural hematoma was identified on the scan and confirmed by arteriography and surgery. In another patient the scan was negative but arteriography demonstrated a large mass lesion which was found at surgery to be an unusual arachnoid cyst. (BBB)

24388 LOCAL RECURRENCE OF BLADDER CANCER AFTER SUPERVOLTAGE IRRADIATION. G. B. Goodman and J. Balfour (British Columbia Cancer Inst., Vancouver). J. Can. Assoc. Radiologists, 15: 92-8(Sept. 1964).

Local tumor recurrence after radiotherapy may result from errors of technique and dosage, or in estimation of treatment volume as well as from radioresistance. This report considers these factors in 265 patients treated by radiation therapy from 1959 to 1963, and suggests that some local recurrences following external radiation therapy may be due to previously unrecognized geographic miss. The survival of patients treated by external ^{60}Co teletherapy was a function of the tumor dose delivered. With identical treatment there were more survivors from the use of higher dosage in the radical group (>5000-rad tumor dose) as compared with the semi-radical (4500 to 5000 rad) group of cases. The causes of death in the two groups show that a greater proportion of the semi-radical group died from intercurrent disease than from metastases. Cystograms before and after irradiation showed that the planned treatment volume frequently did not encompass the bladder adequately throughout the course of treatment, due to distention. The frequency of distention varied such that fractional-to-complete underdose to a portion of the bladder could occur. These results indicate that with a beam-direction technique there was a previously unrecognized risk of geographic miss in 16 out of 37 treated patients. This risk is preventable by catheterization before treatment and continuous drainage during therapy. Postirradiation urine cytology performed in 62 patients showed cell changes in 19 patients. The cell changes were classified as atypical cells, atypical cells-radiation reaction, and suspicious cancer cells. Twelve patients showed atypical cells at some time during followup. Only four patients showed the atypical cells-radiation reaction and three are dead. It is concluded that local cure of a bladder tumor is solely dependent on dose, volume, and tumor sensitivity. It was shown that among patients who died that 35% to 50% of bladders were diseased at death. The doses delivered were considered optimal for the volume treated under the circumstances of treatment. (TCO)

24389 RADIOSENSITIVITY FACTORS IN CERVIX UTERI CANCER. J. Bonte, H. Van den Berghe, and P. Ide (Universite Catholique, Louvain). J. Belge Radiol., 47: 886-95(1964). (In French)

The radiosensitivity of cancer of the cervix uteri depends on the morphological character of the tumor; on the morphological, histological and cytological reactions of the tumor to radiotherapy; and on the reactions of the host to the tumor. The karyotypes of the tumoral cell are of basic and perhaps of decisive importance for the radiosensitivity. (tr-auth)

24390 CLINICAL TESTS OF A METHYL-HYDRAZINE DERIVATIVE AND ITS ASSOCIATION WITH TELECOBALT THERAPY. P. Jacob, J. S. Abatucci, and J. P. Viallaneix (Travail du Centre Regional de Lutte Contre le Cancer, Caen, France). J. Belge Radiol., 47: 896-905(1964). (In French)

Methyl-hydrazine, a new chemotherapeutic agent, was used alone or in association with ^{60}Co γ radiotherapy, in 46 cases of cancer with different localizations. Nausea appeared in half the cases and in a quarter of them this symptom constituted a serious handicap. Hematological tolerance was good. In 6 cases of advanced Hodgkin's disease 4 good results were obtained and 2 with partial improvement. In two out of 3 cases of lymphosarcoma the results were good; no result was obtained in the third. A reticulosarcoma with multiple localizations was favorably influenced. An association with radiotherapy was tried in 11 cases of pharyngolaryngeal cancer and in 11 cases of cancer of the collum. Especially in these last, a certain improvement of the radiosensibility was obtained and this result would justify the study in a larger number of cases. (tr-auth)

24391 CLINICAL APPLICATIONS OF IN VIVO COUNTING. Teruo Nagai (National Inst. of Radiological Sciences, Chiba, Japan). Japan. J. Med., 3: 177-87(July 1964).

Some new diagnostic methods employing radioisotopes are outlined, and examples of their application are presented. The use of ^{125}I and ^{131}I are compared for thyroid, liver, and renal scans. A marked increase in contrast of the space-occupying lesions was shown with ^{125}I. These results showed the advantage in substituting ^{125}I for ^{131}I in scanning. From renal scans performed on 40 subjects, it appears that the ^{203}Hg-Neohydrin renal scan is very effective in evaluating renal lesions. However, 23 to 33% of the dose is retained in the kidneys, as determined with a whole-body counter, which would deliver a relatively high radiation dose to the kidneys. Therefore, the use of ^{57}Co-EDTA to increase renal scanning resolution and to decrease radiation dose was attempted. In spite of the physical half life of 270 days for ^{57}Co, the effective half life measured with the whole-body counter was only 3.2 hr. Lesions which were invisible using ^{203}Hg-Neohydrin were demonstrated with ^{57}Co-EDTA in patients with kidney cysts. Other results showed that significant localization in bone of ^{85}Sr occurred in the head of a patient with Albright's syndrome and in the bone tumors, in particular, in cases where the lesions were progressing. Significant differences in ^{85}Sr retention which might be useful in diagnosis were found in patients with chondrosarcoma and Albright's syn-

drome. A new agent, ^{75}Se-methionine, which is selectively taken up by the pancreas, was prepared, and scans were performed on a subject after total gastrectomy and 5 patients suspected of having pancreas cancer. The scanning was started 10 to 60 min after injection of ^{75}Se-methionine one hr following a high-protein lunch. Visualization of the pancreas in 5 subjects was obtained successfully. Magnetic tape techniques, used to increase the effectiveness of the instrumentation, are also discussed. Whole-body counting procedures employing ^{22}Na, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{131}I are described. (BBB)

24392 RADIOGRAPHY WITH RESONANCE ENERGY NEUTRONS. J. P. Barton (Birmingham Univ., Eng.). Phys. Med. Biol., 10: 209-12(Apr. 1965).

It is shown that it is possible to radiograph objects using beams of monochromatic epithermal neutrons. With the apparatus described areas of a few square inches may be examined with exposures down to a few minutes. In comparison with thermal neutron radiography, resonance energy neutrons enable greater thicknesses of biological material to be examined, and also provide good contrast for small quantities of certain isotopes. These and some other possible advantages of the technique are indicated. (auth)

24393 COMBINED IRRADIATION AND CHEMOTHERAPY IN THE TREATMENT OF SQUAMOUS CELL CARCINOMA OF THE HEAD AND NECK. John F. Daly and Milton Friedman (New York Univ., New York). Trans. Am. Acad. Ophthalmol. Otolaryngol., 68: 625-43(July-Aug. 1964).

Combination of methotrexate with radiation therapy was tested to determine whether the chemical compound enhances the effect of irradiation. This report is based on data from 98 patients who had in all 110 primary squamous cell carcinomas of the head and neck. When combining methotrexate with irradiation, an enhancement effect was assumed to exist when a sublethal (to the tumor) dose of radiation plus methotrexate produces a lethal effect on the tumor similar to that which would ordinarily be produced by a lethal dose of radiation alone. The sublethal dose is from 3400 rad in 18 days for most squamous cell carcinomas of the head and neck, except for a possible rare, extremely radiosensitive tumor. The response of the lesions to methotrexate alone was first ascertained. Sixty % of the lesions treated preliminarily with methotrexate alone shrank significantly (25 to 95% from the effects of the drug alone). Although regional chemotherapy by intra-arterial infusion was more effective than whole-body chemotherapy by the oral route, the complications and technical failures neutralized this advantage. The oral route is preferred in ~90% of head and neck carcinomas and the infusion technique is reserved for cancers of the paranasal sinuses and certain advanced lesions of the tongue and floor of mouth. Oral chemotherapy is particularly useful for cancers of the larynx and pharynx which are inaccessible to the infusion route. Combined methotrexate and radiotherapy was more effective than either modality alone. This enhancement effect was demonstrated when chemotherapy plus radiation doses in a sublethal range (to the tumor) produced effects on carcinoma similar to those produced by irradiation alone in a lethal dose range. Of 17 lesions treated with methotrexate plus sublethal doses of radiation, 10 disappeared for periods of more than one year. These 10 cases comprised the chief evidence for enhancement of irradiation. Two other types of control gave additional support to the concept of enhancement. (BBB)

24394 RADIOACTIVE CAPSULES. Ralph Edward Kidwell and Edward Robert Dalton (to Abbott Labs.). U. S. Patent 3,159,545. Dec. 1, 1964. Filed Oct. 4, 1960.

A radioactive pharmaceutical capsule suitable for oral administration and for transportation without leakage of the contents is patented. The radioactive material to be administered to the patient is incorporated into a vehicle of the suppository type that is a solid at below body temperature (37°C) and melts readily at higher temperatures. The combined radioactive material and vehicle are then contained in any ordinary type capsular material. (B.L.M.)

CHEMISTRY

General

24395 (AWRE-O-14/65) A BALANCE FOR USE IN THERMOGRAVIMETRY INVOLVING RADIOACTIVE MATERIALS. K. C. Steed, H. F. Green, D. R. Terrey, and F. Brown (Atomic Weapons Research Establishment. Aldermaston (England)). Apr. 1965. 39p. Dep.(mn); $1.40(BIS), 7s. (HMSO).

A thermobalance for use with radioactive materials is described which may be operated manually or automatically. Weight changes of up to 5 g may be measured with a precision of ±0.5 mg. The fully enclosed construction of the thermobalance enables reactions to be carried out under static, flow, or vacuum conditions. (auth)

24396 (GNEC-320) INVESTIGATION OF CATALYTIC RECOMBINATION OF RADIOLYTIC OXYGEN AND HYDROGEN. Quarterly Progress Report No. 1, October–December 1963. Gilbert M. Brown, George E. Panter, and C. Thomas Sawyer (General Nuclear Engineering Corp., Dunedin, Fla.). Jan. 10, 1964. Work Performed Under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3151. 54p. (EURAEC-991). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The objective of the program is to investigate the feasibility of reducing the radiolytic gas content of boiling water reactor steam by catalytic recombination, under reactor-like conditions. At least six catalyst candidates were located. Each catalyst will be tested for efficiency under conditions which either normally exist or could be produced in boiling or boiling-superheating reactor systems. These conditions will include steam pressures between 750 and 900 psia, steam temperatures between 515 and 900°F, steam oxygen concentrations between zero and 50 ppm, and steam mass velocities between 5000 and 20,000 lb/hr-ft^2. Catalyst bed depths will be varied between zero and 24 in. Stoichiometric amounts of hydrogen will be added to the steam, along with the oxygen. An existing steam loop in the Bayboro Plant has been altered and will be used for these tests. To date, loop alterations and the initial tests on two catalysts were completed. Data from these tests indicate that it is possible to reduce normal radiolytic gas concentrations in superheated steam by a factor of 100 or more. The first catalyst to be tested was in a spherical form, with particle diameters ranging between about $^3/_{32}$ and $^9/_{32}$ in. Tests were run on this material with bed depths of 18 and 24 in. Data from these tests indicate that as much as 98% of the two gases were combined into steam when the 24-in.-deep bed was in service. The second catalyst tested was a platinum-on-alumina material. This material was also in a spherical form, with diameters in the $^1/_{16}$ to $^3/_{32}$-in. range. Bed depths of 12, 6, and 3 in. of this catalyst were used during three series of tests. Use of each of these depths resulted in removal of greater than 99.5% of the two gases. Both of the materials tested thus far appear to be satisfactory for recombination purposes as far as catalytic activity is concerned. However, use of either would require very special containers under most conditions to prevent the loss of fines from beds. While only a small amount of knowledge has been gained concerning the endurance of either catalyst under test conditions, no indication of poisoning or physical erosion was noted. Both materials suffered a small amount of cracking, apparently during rapid depressurization of the test loop. Probably the most important single observation made to date was the effect of moisture on the second catalyst. During one test, steam temperatures were reduced slowly from about 850°F to the saturation temperature of 514°F. Within one minute after the incoming steam temperature reached the saturation value, significant loss of catalytic efficiency was noted and essentially all activity disappeared as further cooling produced a moisture content of between 0.1 and 0.5% in the steam. Apparently, while no specific degree of superheat is required to allow catalytic activity, the steam must be completely dry. (D.L.C.)

Analytical Procedures

Refer also to abstracts 24592, 24792, and 24807.

24397 (AECL-2136) THE DETERMINATION OF FLUORINE IN POLYPHENYL REACTOR COOLANTS. R. B. Stewart and D. M. Wuschke (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Dec. 1964. 15p. Dep.; $0.50 (AECL)

A method for the analysis for fluorine in polyphenyls and other organic compounds is described. It consists of a decomposition of the organic matrix by combustion in an oxy-hydrogen flame, condensation of the water vapor and hydrofluoric acid produced, concentration and purification of this acid by ion exchange, and determination of the fluoride content by spectrophotometry. Fluoride contents as low as 0.1 parts per million may be measured. (auth)

24398 (AERE-R-4859) THE ANALYSIS OF PLUTONIUM–CHROMIUM CARBIDES. G. W. C. Milner, A. J. Wood, and G. Phillips (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 14p. Dep.; $0.50 (BIS), 2s. 6d. (HMSO).

Methods are described for the chemical analysis of plutonium–chromium carbides containing from 40–92% Pu, 4–40% Cr, and 3–18% C. Sintering with sodium peroxide is employed to dissolve samples either directly or after ignition to oxide. Controlled-potential coulometry is suitable for the direct determination of plutonium contents in 1M H_2SO_4–0.01M potassium pyrophosphate, the pyrophosphate being added to prevent the precipitation of chromium in the preparation of solutions for coulometry. Results are quantitative for 4-mg amounts of plutonium with a coefficient of variation of 0.2%. Chromium is determined by potentiometric titration after separation from plutonium by anion exchange from 8M HNO_3 solutions. After oxidation with argentic oxide, the chromium is reduced with a slight excess of a standard ferrous solution and the excess is titrated potentiometrically with standard ceric sulphate. Results are accurate for 1 mg amounts of chromium by this method with a coefficient of variation of 0.21%. Carbon is determined by combustion to carbon dioxide, followed by manometric measurement of the carbon dioxide produced. Vacuum fusion is suitable for the determination of any contamination of samples by oxygen and nitrogen. (auth)

24399 (HW-78814) SODIUM FLUORIDE CARRIER CONCENTRATION METHOD FOR DETERMINING Al, Be, Ca AND Ti IN PLUTONIUM. C. S. Homi (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 3, 1963. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A spectrochemical method was developed using NaF carrier and standard films for visual semi-quantitative measurements. Standards of 1 to 2000 ppm Al, Be, Ca, and Ti in PuO_2 matrix were prepared and used to study the accuracy of the method. The procedure for Pu metal is given. (D.L.C.)

24400 (KR-91) DETERMINATION OF TRACE ELEMENTS IN PHARMACEUTICALS BY NEUTRON ACTIVATION ANALYSIS. O. Johansen, G. Lunde, and E. Steinnes (Institutt for Atomenergi, Kjeller (Norway)). Feb. 1965. 14p. Dep.(mn).

Neutron activation and gamma spectrometry were used for determination of Cu, Mn, Hg, Zn, Cr, Sb, Co, and Sc in samples of barbiturates, adrenalin, starch, and ascorbic acid. The work indicates that activation analysis is a suit-

able method for determination of trace elements in drugs. (auth)

24401 (KR-92) DETERMINATION OF TRACE ELEMENTS IN ZONE-REFINED ALUMINIUM BY NON-DESTRUCTIVE ACTIVATION ANALYSIS. E. Steinnes (Institutt for Atomenergi, Kjeller (Norway)). Feb. 1965. 12p. Dep.(mn).

Neutron activation and γ-spectrometry were used for the determination of trace elements in "super pure" aluminum before and after zone refinement of the metal. The following elements were determined quantitatively: Cr, Cu, Dy, La, Mn, Nd, Sc, and Sm. Upper limits of contents were established for Co, Fe, Ga, Hg, In, and Zn. It is concluded that non-destructive activation analysis can be a useful aid in studies of zone-refined metals. (auth)

24402 (LA-3258) THE X-RAY ABSORPTION EDGE DETERMINATION OF PLUTONIUM IN URANIUM–PLUTONIUM–MANGANESE ALLOYS. R. G. Hurley, E. A. Hakkila and G. R. Waterbury (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 28, 1964. Contract W-7405-eng-36. 12p. Dep.; $1.00(CFSTI).

Plutonium in uranium–plutonium–manganese alloys is determined using an x-ray absorption edge method in which the intensities of the secondary x rays of niobium and molybdenum transmitted through the sample solution are measured. These secondary x rays are generated by irradiating a niobium–molybdenum metal target with x rays from a tungsten-target x-ray tube and are transmitted through an absorption cell filled successively with water, suitable standards, and the sample solution. The L III absorption edge for plutonium at 0.686 A. occurs between the $K\beta_1$ line for niobium and the Kα line for molybdenum at 0.666 and 0.710 A., respectively. Measured transmitted intensities of these lines are related to plutonium concentrations using accepted absorption principles. The method is applicable to the determination of plutonium concentrations in the range between 30 and 100% with relative standard deviations in the range between 0.91 and 0.55%. Only radon, radium, neptunium, and americium have absorption edges between the x-ray lines used for analysis and cause interference. (auth)

24403 (NP-14952) METHODS OF ANALYSIS OF METAL REFRACTORIES—BORIDES, CARBIDES AND NITRIDES OF HAFNIUM, NIOBIUM, TANTALUM, TITANIUM AND ZIRCONIUM. Technical Report No. C-29. R. E. Dutton, G. J. McKinley, D. McLean, and H. F. Wendt (Union Carbide Research Inst., Tarrytown, N. Y.). Feb. 1965. Contract DA-30-069-ORD-2787. 25p.

Accurate analytical methods are given which are based on those of O. H. Kriege. Procedural changes and improvements in Kriege's methods are detailed. Typical results are given. (D.L.C.)

24404 (PG-Report-469(Rev.)) ANALYTICAL METHOD FOR THE DETERMINATION OF (A) TRITIATED WATER AND (B) TRITIUM AND TRITIATED HYDROCARBONS IN REACTOR COOLANT GAS. (Production Group, United Kingdom Atomic Energy Authority, Sellafield (England)). 1965. 17p. Dep.(mn); $0.50(BIS); 2s. 6d. (HMSO).

Tritiated water is washed from the gas, purified, and the β activity measured. The carbon dioxide in the dried gas is absorbed in potassium hydroxide and the hydrogen and hydrocarbons in the residual gas oxidized. The water produced is purified and its β activity measured. The concentration range is 1×10^4 to 1×10^8 d.p.m./liter of coolant, and the detection limit is 1×10^4 d.p.m./liter of coolant. (auth)

24405 (PG-Report-625) ANALYTICAL METHOD FOR THE VOLUMETRIC DETERMINATION OF URANIUM TRIFLUORIDE IN THE PRESENCE OF URANIUM TETRAFLUORIDE AND DIOXIDE. (Production Group, United Kingdom Atomic Energy Authority, Springfields (England)). 1965. 7p. Dep.; $0.30(BIS), 1s. 9d. (HMSO).

A weighed portion of the sample is dissolved in phosphoric acid containing ferric ion. The ferrous ion resulting from the reduction by U^{III} is titrated potentiometrically with a standard uranyl solution. The method is suitable for the determination of 2.5 to 135 mg U^{III}. The method has been employed for the determination of (a) 65–85% UF_3 in the presence of uranium tetrafluoride and dioxide as the balance, and (b) 0.5 to 6% UF_3 in mixtures of uranium tetrafluoride with alkali and alkaline earth fluorides. Uranium metal and/or U^{VI} interferes but may be corrected for if the concentrations are known. Three duplicate determinations on samples of uranium trifluoride determined at 67, 78, and 79% UF_3 agreed within 0.4, 0.3, 0.0% (abs.) respectively. (auth)

24406 (PG-Report-632) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF SILICON IN URANIUM COMPOUNDS BY THE TOTAL DISSOLUTION METHOD. (Production Group, United Kingdom Atomic Energy Authority, Springfields (England)). 1965. 7p. Dep.; $0.30(BIS), 1s. 9d. (HMSO).

The sample is dissolved in a mixture of nitric and hydrochloric acids, and the silicon is solubilized by digestion with hydrofluoric acid. After complexing fluoride with boric acid, the silicon is determined by conversion to silico molybdic acid, which is then reduced to "molybdenum blue" and the absorbancy of the solution measured using a spekker absorptiometer. The method is applicable to uranyl nitrate, ammonium diuranate, uranium dioxide powder and sintered pellets, and U_3O_8, containing 30–600 ppm silicon on a uranium basis. The method is considered to be without bias, and the standard deviation should not exceed 5 ppm at the 100 ppm level. (auth)

24407 (RFP-522) AN AUTOMATIC SYSTEM FOR THE DETERMINATION OF OXYGEN IN BERYLLIUM METAL COMPONENTS. J. T. Byrne, C. T. Illsley, and H. J. Price (Kaman Nuclear Div., Kaman Aircraft Corp., Colorado Springs, Colo.). 1965. Contract AT(29-1)-1106. 25p. (CONF-650405-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

An instrument was developed for the automatic and nondestructive determination of oxygen in beryllium. Beryllium components are exposed to 14-Mev neutrons from a deuterium-tritium source. The component is transferred by a mechanical trapeze to a 5-inch NaI(Tl) gamma detector where the 6-7 Mev gamma rays from nitrogen-16 are counted. A standard is irradiated simultaneously and counted in a separate detector. A custom-design electronic digital computer calculates the percent oxygen which is printed out by an automatic typewriter. The complete irradiation, transfer, counting, and calculating operation requires two minutes. The analysis is performed by an automatic system. At oxygen concentrations of 1–2%, the relative standard deviation of this method is less than ±4%. This compares favorably with existing chemical methods. In addition, the automatic activation analysis is much more rapid than chemical methods, is non-destructive, and is not subject to errors from surface oxidation of sample chips. Errors can be caused in this activation method, as in methods requiring sampling, if the oxygen is not homogeneously distributed through the metal piece. (auth)

24408 A SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF THORIUM WITH ACID ALIZARIN BLACK SN. Praphan Kusakul and T. S. West (Univ. of Birmingham, Eng.). Anal. Chim. Acta, 32: 301–8 (Apr. 1965).

Acid alizarin black SN reacted with thorium at pH 4.2 to give a highly sensitive color reaction, $\epsilon_{600\ m\mu} = 28{,}000$. There was no interference from Ba, Ca, Cd, Ce(III), Gd, Hg, La, Mg, Mn, Pb, Pr, Sm, Sr, Zn, Zr, Cl^-, CN^-, I^-, NO_3^-, or SO_4^{2-}. The interferences of Al, Bi, Co, Cu, Fe, Ni, Mo, Sb, Sn, Ti, and W may be overcome by addition of masking agents. Only U(VI) and V(V) still interfere and these can be determined sequentially with the thorium. The nature of the complex and the mode of its formation were studied. (auth)

24409 VOLTAMMETRY AND CONTROLLED-POTENTIAL COULOMETRY WITH BORON CARBIDE ELECTRODES. W. R. Mountcastle, Jr. (Oak Ridge National Lab.,

Tenn.). Anal. Chim. Acta, 32: 332-8(Apr. 1965). (ORNL-P-187)

With the boron carbide electrode, $E_{p/2}$ values were determined for the reduction of the following ions: Cd(II), Co(II), Cu(II), Fe(III), Ni(II), Pb(II), Ru(V), Sb(V), and U(VI). The linear dependence of peak current on concentration was demonstrated for the U(VI) → U(IV) and Fe(III) → Fe(II) reductions at the boron carbide electrode. The suitability of the electrode for the controlled-potential coulometric titrations of Fe(II) → Fe(III), Fe(III) → Fe(II), and U(VI) → U(IV) was studied; the results were inconclusive because of the small surface area that could be used conveniently and the possibility of oxygen leaks in the cell. (auth)

24410 DETERMINATION OF SURFACE OXYGEN ON METALS BY NEUTRON ACTIVATION. W. Leonhardt (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Anal. Chim. Acta, 32: 355-69(Apr. 1965). (In German)

Surface oxygen on metal foils was determined by activation analysis on the basis of the reaction sequence $^{6}Li(n,\alpha)t$, $^{18}O(t,n)^{18}F$. The metal foils were placed between foils consisting of lithium fluoride and polystyrene, sealed in evacuated ampoules, and irradiated in a reactor. The produced ^{18}F was radiochemically separated, and measured by its annihilation radiation at 0.51 Mev. The overall cross sections of such foil arrangements were computed and compared with experimental data. Instructions are given for the chemical treatment of irradiated foils of Au, Pt, Ni, Cu, Al, Fe, and Zr. The following values of oxygen coverage were found on rolled foils: Pt, 1.4; Ni, 1.4; Cu, 2.9; Al, 4.9; and Fe, 7.5 μg O/cm^2 of geometrical surface. Other oxygen values are given for Au, Zr, and different pretreatments of the metal surfaces. The lower limit of determination was about 0.1 μg O/cm^2. (auth)

24411 A HIGH VACUUM LINE FOR OPERATIONS IN THE GASEOUS STATE IN THE TECHNIQUE OF ^{14}C AND TRITIUM. H. W. Scharpenseel (Universitat, Bonn). Atompraxis, 11: 147-50(Mar. 1965). (In German)

A high vacuum line is described with the space requirement of one normal line, however, combining the possibilities of ^{3}H and ^{14}C-gas phase determination and ^{3}H and ^{14}C direct labeling according to Wilzbach or Turton, as well as various functions in the field of synthesis, degradation, vacuum distillation, -fractionation, and -drying. (auth)

24412 THE POSSIBILITY OF CORRECTING THE DISTURBING INFLUENCES OF ACCOMPANYING ELEMENTS ON THE DETERMINATION OF A PARTICULAR ELEMENT IN ACTIVATION ANALYSIS. M. Rakovic and H. Talpova (Charles Univ., Prague). Atompraxis, 11: 151-3(Mar. 1965). (In German)

In the determination of an element by means of neutron activation analysis, it is possible to eliminate the additional activity and/or impulse rate resulting from the concomitant activation of other elements by making a simple mathematical correction. In practical use, a nomograph is introduced from which the correction coefficient can be read off. With this, the measured impulse rate can be reduced to the activity of the element to be determined. (auth)

24413 THE INFLUENCE OF THE IMPERATIVES OF UTILIZATION AND OF THE PRODUCTION POSSIBILITIES ON THE CHOICE OF ANALYTICAL METHODS. Roger Platzer and Guy Baudin (CEN, Saclay, France). Bull. Soc. Chim. France, No. 2, 535-8(Feb. 1965). (In French)

The determination of lithium in Al–Li alloys is used as an example of the influence of production variables on the choice of analytical methods. Homogeneity during sampling and the desire of the user for the non-destruction of the sample, among other considerations, has led to the utilization of several methods of analysis (chemical, spectrographic, neutron, and densimetric). The advantages and disadvantages of each method were studied. (tr-auth)

24414 ANALYSIS OF BERYLLIUM BY SPARK MASS SPECTROMETER. Mithat Nalbantoglu (Compagnie Pechiney-Saint-Gobain, Croix-de-Berny, France). Bull. Soc. Chim. France, No. 2, 539-44(Feb. 1965). (In French)

Although the conventional methods of analysis are sometimes insufficient for the detection of trace impurities in metals of nuclear purity or in semiconductors, mass spectrometry makes it possible to attain sensitivity limits of the order of 0.01 ppm and even 0.001 ppm in the analysis of solids by using a spark source. Ionic collection is made on photographic plates. The interpretation of the plates is made by giving some details on the manner of identifying the different rays and the method used to obtain a quantitative analysis. The results of the complete analysis of a sample of pure beryllium (Pechiney) are discussed. (tr-auth)

24415 ROUTINE ACTIVATION ANALYSIS OF SOME COMMON IMPURITIES IN BERYLLIUM. Charles Engelmann, James Gosset, and Monique Loeuillet (Commissariat a l'Energie Atomique, [Paris]). Bull. Soc. Chim. France, No. 2, 544-7(Feb. 1965). (In French)

Activation analysis is used for the systematic control of the preparation of electrolytic beryllium and its refining by fusion or distillation under vacuum. Two types of activation are used. The first uses thermal neutrons and is for the analysis of the elements Al, Cl, Co, Cr, Cu, In, K, Mn, Na, Si, Ta, V, W, and Zn. The second is based on (γ,n) activation with a beam of bremsstrahlung γ rays with a maximum energy of 28 Mev. It is used for the determination of O, C, N, and eventually of F. The majority of the analyses are non-destructive and very rapid. The range of sensitivities is from 1 to 10^{-4} ppm, according to the nature of the impurity. (tr-auth)

24416 DETERMINATION OF IMPURITIES IN TANTALUM AND NIOBIUM BY NEUTRON RADIOACTIVATION. Guy Aubouin (CEN, Grenoble, France), Francois Dugain, and Jean Laverlochere. Bull. Soc. Chim. France, No. 2, 547-51(Feb. 1965). (In French)

Activation analysis was applied to the determination of trace impurities in tantalum and niobium by irradiation in a reactor and with an accelerator (neutrons of 14 Mev). The chemical exchange by ion exchange resins is described. In the case of tantalum, these separations should be made in a hot cell and should lead to high decontamination coefficients with respect to tantalum because of its high radioactivity. The results obtained, usually by counting on a gamma spectrometry installation, are given for a certain number of samples analyzed. Some determinations of oxygen in these materials were made by activation with neutrons at 14 Mev. (tr-auth)

24417 DETERMINATION OF BORON IN THE ALLOYS Zr–U–B. C. Boirie, Guy Baudin, J. Cittanova, and Roger Platzer (CEN, Saclay, France). Bull. Soc. Chim. France, No. 2, 551-2(Feb. 1965). (In French)

The determination of boron in the alloys Zr–U–B is a problem of industrial control. The choice was oriented towards a spark spectrographic method that does not require a preliminary preparation and is practically non-destructive. It is shown how the problems of homogeneity eliminated this method and how the solution was obtained by the use of a group of methods: separation of boron by pyrohydrolysis, chemical determination, and spectrographic control of the residual oxide. (tr-auth)

24418 THE ANALYSIS OF PURE ZIRCONIUM BY NEUTRON RADIOACTIVATION. Eliezer Paul Mignonsin and Philippe Albert (Centre d'Etudes de Chimie Metallurgique, Vitry, France). Bull. Soc. Chim. France, No. 2, 553-61(Feb. 1965). (In French)

The dissolution of zirconium in a mixture of hydrofluoric and nitric acids leads to the formation of very stable fluoride complexes of zirconium simultaneously with the oxidation of the sulfur and phosphorus into sulfate and phosphate ions. Thus the precipitation of the zirconium phosphate $ZrO(H_2PO_4)_2$, insoluble even in 20% H_2SO_4 solution, and the formation of the compounds $ZrSO_4^{2+}$, $Ar(SO_4)_2$, and $Zr(SO_4)_3^{2-}$ is prevented. Ion exchange chromatography on 1-X Dowex resin 200 to 400 mesh makes possible an immediate separation of the radioisotopes into eight groups. The method was applied to the analysis of samples of industrial Zr prepared by the Kroll process (reduction of zirconium chloride by magnesium) and the Van Arkel process (dissociation of zirconium iodide), as well as to the study of the purification obtained by the fused zone method. (tr-auth)

24419 DETERMINATION OF OXYGEN IN NIOBIUM, TANTALUM, AND BERYLLIUM. Jacques Bril and Francois Dugain (Laboratoires de Recherches d'Electrometallurgie et des Metaux Nouveaux, Grenoble, France). Bull. Soc. Chim. France, No. 2, 562-4(Feb. 1965). (In French)

Improvements to simplify manipulations and to increase exactitude and fidelity in the determination of oxygen are suggested. The method uses the device for the determination of gases in metals constructed by the Stroehlein Firm of Dusseldorf; it consists of operating the reducing fusion under vacuum of the metal considered in an iron bath whose concentration in the metal analyzed is maintained constant and is determined in such a fashion as to obtain an alloy at a fusion point as low as possible, compatible with the thermodynamic requirements of the reaction. An analogous method, using a copper bath and a progressive rise in temperature, was developed for the analysis of beryllium. The metal can be analyzed in massive or powder form at the rate of 60 individual determinations per week for concentrations from 200 to several thousand ppm (the hydrogen concentration was assumed to be very low). The results, which present no systematic error, are reproducible to about 15% for average concentrations. (tr-auth)

24420 DETERMINATION OF NIOBIUM AND TANTALUM IN ROCKS AND MINERALS BY NEUTRON ACTIVATION. J. C. Ricq, J. P. Vidal, M. Capitant, and G. Troly. Chim. Anal. (Paris), 47: 77-80(Feb. 1965). (In French)

A method is described for routine application to analysis of Nb and Ta ores with very variable composition and concentration of about ten grams per ton or several tenths of one percent. The reproducibility is very good and the precision is 5% for concentrations higher than several tenths of 1% and 10% for concentrations below 0.01%. The determination of Nb and Ta in steels and alloys is possible by an analogous method. (tr-auth)

24421 NEW REAGENTS FOR DETECTION OF URANYL CATIONS. O. Leminger and M. Farsky. Collection Czech. Chem. Commun., 30: 345-6(Jan. 1965). (In German)

Reactions for the detection of uranyl cations by the formation of blue-colored complex compounds of uranyl cations with methanol solutions of glyoxal-bis(2-hydroxy-5-chloranil) are described. The reaction sensitivity is pD = 5. Only the ions Ce^{4+}, Zr^{4+}, and $(MoO_4)^{2-}$ interfere. (tr-auth)

24422 URANIUM IN OILS OF THE DNIEPER-DONETS AND PRIPYAT DEPRESSION. V. A. Filonov (Inst. of Geology, Academy of Sciences, Belorussian SSR). Dokl. Akad. Nauk SSSR, 159: 355-6(Nov. 11, 1964). (In Russian)

The uranium content in crude oil samples from the Ukraine and from Belorussia was determined by a luminescence method. The crude oil samples were evaporated down in porcelain crucibles to formation of a coke which was ashed in a muffle furnace at 450 to 500°C. Uranium was extracted from the ash by boiling with a mixture of HNO_3 and HCl. The uranium content was found to vary from 0.42 to 8.7×10^{-6}% for the ash, or from 1.48 to 18.9×10^{-7} g per liter of crude oil. The highest uranium contents were found in crude oils having low ash contents. The data indicate that uranium is associated with the organic part of the crude oil, and not with impurities that accidentally find their way into the crude oil. (TTT)

24423 THE EXTRACTION SYSTEM OF $La(NO_3)_3$–NH_4NO_3–H_2O–$(C_4H_9O)_3PO$. A. V. Nikolaev, A. A. Kolesnikov, and T. P. Smirnova (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 159: 379-82(Nov. 11, 1964). (In Russian)

A complete description is given for the extraction system. The densities of the organic and aqueous phase, the distribution coefficients (K_D) of $La(NO_3)_3$ and H_2O, and the equilibrium concentrations of $La(NO_3)_3$ and H_2O in the organic phase, and of $La(NO_3)_3$ and NH_4NO_3 in the aqueous phase at 25°C are presented in tabular form. The distribution coefficients (K_D) $La(NO_3)_3$ and H_2O are also plotted as isolines as a function of the wt.% of $La(NO_3)_3$, H_2O, and NH_4NO_3. The K_D of $La(NO_3)_3$ varies from 0.1 to 70. The extraction of La increases smoothly with increasing concentration of the NH_4NO_3 salting agent (above 10 wt.%), and with decreasing concentration of $La(NO_3)_3$. At least 10 wt.% NH_4NO_3 is required in order to extract $La(NO_3)_3$ efficiently by TBP. The K_D of H_2O varies from 0.01 to 0.19. The number of extraction stages, the minimum amount of organic solvent, and the compositions of the aqueous and organic phase can be determined from the data from any process based on this system. (TTT)

24424 EFFICIENCY OF DRINKING WATER DECONTAMINATION FROM RADIOACTIVE SUBSTANCES WITH CERTAIN NATURAL SORBENTS. E. I. Orlova, T. P. Gorbatenkova, V. E. Kolokolova, K. D. Pronina, and V. A. Smirennaya. Gigiena i Sanit., No. 2, 50-4(Feb. 1965). (In Russian)

The practice of decontaminating drinking water from radioactive substances by means of certain natural sorbents was investigated. A study into the efficiency of radioactive isotopes' removal from the drinking water by using merainic loam medium grained alluvial sand and wood ash, showed the loam to be the best sorbent. The degree of water decontamination from radioisotopes of strontium, barium, calcium, cerium, cesium, ruthenium, zirconium, and niobium achieved with loam amounted to 98%. The radioactive isotopes of molybdenum and iodine present in water in the form of molybdate and iodide ions were not absorbed by natural sorbents. (auth)

24425 AMPEROMETRIC STUDIES ON FERROCYANIDE COMPLEX OF URANIUM. H. C. Saraswat and R. N. Parnerkar (Christ Church Coll., Kanpur, India). Indian J. Chem., 3: 178-9(Apr. 1965).

The composition of uranyl ferrocyanide complex, investigated amperometrically, was shown to be $(UO_2)_3K_2[Fe(CN)_6]_2$ or $(UO_2)_2Fe(CN)_6 \cdot UO_2K_2Fe(CN)_6$. The results showed that uranium can be estimated amperometrically, by titrating against potassium ferrocyanide, within an experimental error of 1%. (auth)

24426 SPECTROPHOTOMETRIC DETERMINATION OF IRON, NICKEL AND URANYL IONS WITH α-MERCAPTOPROPIONIC ACID. F. Baykut and A. Gueran (Univ. of Istanbul). Istanbul Univ., Fen Fak. Mecmuasi, Seri C, 29: 153-60(July-Oct. 1964).

Three new spectrophotometric methods based on the colored complexes of iron, nickel, and uranium with α-mercaptopropionic acid were developed. For 0,01–0,3 mmole/l Fe^{3+}, 1–15 mmole/l Ni^{2+} and 0,25–4,5 mmole/l UO_2^{2+} maxima absorptions were at 514, 495, and 384 mμ, respectively. (auth)

24427 DETERMINATION OF URANIUM IN WATER SOURCES IN THE VITOSHA MOUNTAIN BY MEANS OF DIFFERENTIAL LUMINESCENCE PHOTOMETER. K. Nikolov and H. Kambourov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 10: 67-73(1962). (In Bulgarian)

Investigations were made on the uranium content of the Vitosha waters. Determinations were performed on samples taken from 40 very typical locations chosen among those with high, medium, or low radon concentrations. The uranium, chemically purified of quenchers, was photometrically determined by means of a two-channel differential photometer, specially constructed for this purpose. The amounts of uranium in these Vitosha water sources are of the order of 10^{-7} g/l. They do not exceed the relatively low maximum permissible health-standards for water concentrations. The corresponding values calculated for radium on the basis of existing radioactive equilibrium vary from 0.9 to 3.8×10^{-14} g/l. The differential luminescence photometer in combination with the chemical methods developed make possible the determination of traces of uranium with a precision of 10%. (auth)

24428 FACTORS INFLUENCING THE PRECISION OF THE LUMINESCENT METHOD FOR URANIUM DETERMINATION. V. Mikhailova and H. Raichev. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 12: 115-20(1964). (In Bulgarian)

The different factors influencing the process of preparation and photometry of uranium beads were investigated. The dependence of photoluminescence on the kind of flame

used, on the quantity of the melting mixture, on the time of stay in the oxidation zone of a benzene burner flame, and on the necessary time interval preceding the photometry of the beads was studied. Further, the values of the correction coefficients were established by comparing the photoluminescence of uranium beads with that of uranium glasses of the LUF-57 (Photoelectric Luminescence Photometer). (auth)

24429 TRACER DETERMINATION OF THE AMOUNT OF LANTHANUM COPRECIPITATION IN BARIUM–STRONTIUM TITANYL OXALATE. W. R. Northover (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Am. Ceram. Soc., 48: 173-5(Apr. 21, 1965).

The degree of lanthanum coprecipitation attained in the synthesis of semiconducting $BaTiO_3$ by chemical precipitation of the mixed oxalates was determined by radioactive tracer techniques. The factors affecting reproducibility and efficiency of precipitation were determined and a probable mechanism for the incorporation of the lanthanum is proposed. (auth)

24430 A CHROMATOGRAPHIC METHOD FOR ANALYSIS OF STRONTIUM-90 IN FOODS. Leonard A. Ford and Mae S. Walton (Div. of Pharmacology, Food, and Drug Administration, Washington, D. C.). J. Assoc. Offic. Agr. Chemists, 48: 415-16(Apr. 1965).

The daughter, ^{90}Y, can be separated from the parent nuclide, ^{90}Sr, on a partition column with HDEHP as mobile phase on a Celite Substrate. The ingrowth of yttrium and its subsequent removal and counting serves as a determination of strontium-90. The advantages and disadvantages of this system are contrasted with those of the shake-out method from which it was derived. (auth)

24431 USE OF 2-ETHYLHEXYL PHENYLPHOSPHONIC ACID IN REVERSED PHASE PARTITION CHROMATOGRAPHY. I. Fidelis and S. Siekierski (Inst. of Nuclear Research, Warsaw). J. Chromatog., 17: 542-8 (Mar. 1965).

Reversed phase partition chromatography with 2-ethylhexyl phenylphosphonic acid retained on kieselguhr as the stationary phase was applied to the separation of rare earths. A comparison with other extracting agents used in partition chromatography was made. (auth)

24432 THE SEPARATION OF THE LANTHANIDES AND YTTRIUM BY CATION EXCHANGE ELUTION WITH AMMONIUM α-HYDROXYISOBUTYRATE AND LACTATE. H. Deelstra and F. Verbeek (Univ. of Ghent). J. Chromatog., 17: 558-66(Mar. 1965).

The separation of the lanthanides and yttrium by cation exchange elution from Dowex-50 WX resin columns with α-hydroxyisobutyrate and lactate solutions was investigated with and without addition of ammonium perchlorate. Addition of an indifferent electrolyte to the eluant decreases the practical separation efficiency. This phenomenon can be explained from complex formation data. From the variation of the logarithm of the distribution coefficient as a function of the logarithm of the ligand concentration, $[L^-]$, in absence of an indifferent electrolyte, no valid conclusion can be drawn concerning the complexes formed in solution, contrary to the measurements in the presence of an indifferent electrolyte. (auth)

24433 A SPECIFIC METHOD FOR THE SEPARATION OF RHENIUM BY ANION EXCHANGE CHROMATOGRAPHY. Kazuaki Kawabuchi, Hiroshi Hamaguchi, and Rokuro Kuroda (Tokyo Kyoiku Univ.). J. Chromatog., 17: 567-73(Mar. 1965).

A systematic survey of the adsorbabilities of cations with a strong base type resin, Dowex I, X-8, in a thiocyanate-hydrochloric acid system indicates that the difference between the distribution coefficient of Re(VII) and those of a considerable number of other ions is large enough for good separation. This fact provides the means of developing an anion exchange chromatographic procedure for the separation of Re(VII) from other ions. Re(VII) is eluted with 0.5 M NH_4SCN–0.5 M HCl, while alkali metals, alkaline earth metals, rare earths, Y(III), Cr(III), Al(III), As(III), and Ge(IV) are eluted earlier in the effluent from the sample solution. Ions forming thiocyanate complexes such as Zn(II), Cd(II), Hg(II), Cu(II), In(III), Ga(III), Sn(IV), V(V), Sb(III), Sb(V), Bi(III), W(VI), Fe(III), Co(II), Ru(III), and U(VI), are retained on the column. An effective eluting system for these ions is also given. Separations of Re(VII) from 38 metal ions are reported. (auth)

24434 SEPARATION OF THE RADIOLYSIS PRODUCTS OF o-IODOBENZOIC ACID. Marianna Mantel and Esther Kushnir (Soreq Research Establishment, Yavne Soreq, Israel). J. Chromatog., 17: 624-5(Mar. 1965).

A method was developed that permits the separation and semi-quantitative determination of the radiolysis products of o-iodobenzoic acid by means of ascending chromatography, using a single solvent consisting of benzene-propionic acid-water (2:2:1). The acids were detected by four different methods: spraying; uv illumination; in the case of benzoic acid, which does not react with the developers used in this solvent, detection was performed by automatic scanning or by autoradiography, in comparison with ^{14}C-labeled standards; diphenic acid was detected by two-dimensional chromatography using two different solvents. Differences between the R_F values of the individual acids were large enough to permit identification on the same paper strip. If quantitative determination is required, the strips may be cut at the respective R_F values, the acids eluted, and their uv absorbance determined with a spectrophotometer. (P.C.H.)

24435 CHROMATOGRAPHY ON ION EXCHANGE PAPERS. XVII. THE ADSORPTION OF METAL IONS ON CATION AND ANION RESIN PAPERS FROM NITRIC ACID. L. Ossicini (CNR, Rome). J. Chromatog., 17: 625-8(Mar. 1965).

Studies were made to determine the adsorption of metal ions from nitric acid. In the technique used, the nitrate form of the anion resin paper was prepared by equilibrating the chloride form with an ammonium nitrate solution. The cation resin paper was used in the hydrogen form. The results showed that there was an increase in adsorption above 6 N HNO_3 on the cation resin paper of the same magnitude as was observed in perchloric and hydrochloric acids. All the rare earths have almost identical R_F curves on the cation resin paper in spite of the fact that the early rare earths yield neutral and anionic complexes. The anion exchange behavior confirmed essentially data reported previously with column experiments. (P.C.H.)

24436 DETERMINATION OF AURIC IONS IN COLOIDAL GOLD-198 BY PAPER ELECTROPHORESIS. U. Been and A. Hoeye (Institutt for Atomenergi, Kjeller, Norway). J. Chromatog., 17: 631-2(Mar. 1965).

A quantitative method using paper electrophoresis was worked out for the determination of gold ions in colloidal ^{198}Au. The accuracy of the methods as established by comparison with paper chromatography corresponds to a deviation of 30% or less in the lower ionic region (1-2% ionic gold). The accuracy was far better in the higher ionic region. The results also showed that 0.075 M sodium thiosulfate does not change the percentage of gold ions in colloidal ^{198}Au preparations. (P.C.H.)

24437 SEPARATION OF NIOBIUM AND TANTALUM FROM EACH OTHER WITH N-BENZOYL-N-o-TOLYLHYDROXYLAMINE. A. K. Majumdar and Bijoli K. Pal (Jadavpur Univ., Calcutta). J. Indian Chem. Soc., 42: 43-5 (Jan. 1965).

N-Benzoyl-N-o-tolylhydroxylamine provided a satisfactory separation of Nb from Ta in a cold tartrate solution in the pH range from 5.0 to 6.5, even when these ions were present in the ratio of 1:17 to 21:1. Nb precipitated quantitatively from solutions with acidity ranging from 10% sulfuric acid to a pH of 6.7; Ta precipitated quantitatively from 10% sulfuric acid solution to a pH of 1.8. Only Ti and Zr interfered in the determination of Nb at a higher pH of 4.5 to 6.0, whereas Ti, Zr, MoO_4^{2-}, and WO_4^{2-} interfered in the determination of both Ta and Nb from a 10% sulfuric acid solution. (auth)

24438 THE COMPLEXING POWER OF HYDROXAMIC ACIDS AND ITS EFFECT ON THE BEHAVIOUR OF ORGANIC EXTRACTANTS IN THE REPROCESSING OF IRRADIATED FUELS. I. THE COMPLEXES BETWEEN BENZOHYDROXAMIC ACID AND ZIRCONIUM, IRON(III) AND URANIUM(VI). F. Baroncelli and G. Grossi (CNEN and CSN, Casaccia-Rome). J. Inorg. Nucl. Chem., 27: 1085-92 (May 1965).

An investigation was made on the formation of complexes between the simplest arylhydroxamic acid and the Zr^{4+}, Fe^{3+}, and UO_2^{2+} ions. The values were determined for the stability constants of the complexes of zirconium and iron (III) ions with benzohydroxamic acid (using the distribution method), and of the complex between uranyl ion and the same acid (using the pH-potentiometric method). These values are: $\beta_1(Zr) = 2.7 \times 10^{12}$; $\beta_2(Zr) = 1.2 \times 10^{24}$; $\beta_1(Fe) = 1.5 \times 10^{12}$; $\beta_1(UO_2) = 5.2 \times 10^8$; and $\beta_2(UO_2) = 5.9 \times 10^{16}$. The very high stability of the zirconium complexes supports the hypothesis recently formulated by others concerning the responsibility of the hydroxamic functions, formed by chemical and radiolytic damage, in the retention of zirconium by solvents used in the reprocessing of irradiated nuclear fuels. (auth)

24439 THE ULTRA-VIOLET ABSORPTION SPECTRA OF NITRIC ACID AND METAL NITRATES IN TRI-N-BUTYL PHOSPHATE SOLUTIONS. J. L. Woodhead (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 1111-16(May 1965).

Covalent nitrate bonding in TBP solutions of nitric acid and metal nitrates shifts the nitrate absorption band (λ_{max} 303 mμ for nitrate ion in aqueous media) to lower wavelengths. In TBP, the spectrum of lithium nitrate is the same as that in water, whereas nitric acid has λ_{max} at 273 mμ; other metal nitrates show intermediate shifts in the order $LiNO_3 < Mg(NO_3)_2 < Ca(NO_3)_2 < Al(NO_3)_3 < La(NO_3)_3 < Th(NO_3)_4 < HNO_3$. Ionic nitrate in TBP phases containing uranyl nitrate promotes the formation of the trinitrato uranyl complex, and the extent to which the latter is formed by the above mentioned series of nitrate solutions corresponds to the increase of covalency indicated by the spectral shifts. (auth)

24440 SODIUM AND STRONTIUM EXTRACTION BY DI(2-ETHYLHEXYL) PHOSPHATE: MECHANISMS AND EQUILIBRIA. W. J. McDowell and C. F. Coleman (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 1117-39(May 1965). (ORNL-P-436)

The extraction of sodium and strontium by di(2-ethylhexyl)phosphoric acid (HA or HDEHP) in benzene was examined over the complete loading range from trace concentration to reagent saturation, i.e., formation of the normal salt NaA(NaDEHP) or $SrA_2(Sr(DEHP)_2)$. Trace strontium extraction from 0.50 and 4.00 M $NaNO_3$ by mixtures of HA and its sodium salt, NaA, was examined from zero to 100% NaA. Extraction equilibrium curves (organic vs aqueous concentration), hydrogen ion, and reagent-concentration dependences were examined in all cases, and, for strontium extraction by mixed HA–NaA, sodium-ion dependence was examined. The data indicate that the reaction for sodium extraction by the acid dimer, $(HA)_2$, is $Na^+ + 2(HA)_2 \rightleftharpoons NaA \cdot 3HA + H^+$ up to 25% NaA. Additional sodium extraction results in tetramer destruction to yield the salt NaA. The reaction for strontium extraction by $(HA)_2$ is similar: $Sr^{2+} + 3(HA)_2 \rightleftharpoons SrA_2 \cdot 4HA + 2H^+$. Also similarly, ultimate loading leads to the salt SrA_2. Both these salts are polymerized. Trace strontium extraction by mixed HA–NaA is most readily described by the equation: $Sr^{2+} + (n/y)(aHA \cdot bNaA)_y \rightleftharpoons (l/x)(SrA_2 \cdot (n-2)(\alpha HA \cdot \beta NaA))_x + lH^+ + jNa^+$, where the extractant is characterized as a mixed, y-fold polymer containing a fraction of HA and b fraction of NaA. The data indicate that strontium extracts as $SrA_2 \cdot 4HA$ at least up to organic-phase compositions of 40% NaA. At higher NaA concentrations the interpretation is less certain but suggests the extraction of strontium into NaA micelles. (auth)

24441 DISTRIBUTION OF β-DIKETONES AND SCANDIUM THENOYLTRIFLUOROACETONATE IN MIXED SOLVENT SYSTEMS. S. Oki, T. Omori, T. Wakahayashi, and N. Suzuki (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem., 27: 1141-50(May 1965).

The distribution of some β-diketones and of scandium thenoyltrifluoroacetonate between a mixed organic solvent and an aqueous solution was investigated. In the systems composed of two organic solvents which are non-polar or almost non-polar, the regular solution theory gives a satisfactory explanation. Synergisms were observed in the mixed solvent systems composed of a polar solvent and benzene in case of trifluoroacetylacetone, thenoylacetone, and thenoyltrifluoroacetone, while in case of acetylacetone the synergism did not appear in any system except ones containing nitrobenzene. On the distribution of scandium thenoyltrifluoroacetonate the synergism appears and the degree of this effect was found to be larger than that of the β-diketone. It was found that, in the mixed solvent systems, there is a correlation between the distribution coefficients of scandium thenoyltrifluoroacetonate and those of thenoyltrifluoroacetone. (auth)

24442 A STUDY ON URANYL PHOSPHATES. II. SORPTION PROPERTIES OF SOME 1- TO 4-VALENT CATIONS ON URANYL HYDROGEN PHOSPHATE HEATED TO VARIOUS TEMPERATURES. V. Pekarek and V. Vesely (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 27: 1151-8(May 1965).

The sorption properties of uranyl hydrogen phosphate heated to 30, 330, 710 and 1020°C were studied for some 1- to 4-valent cations. From the changes in the sorption properties qualitative conclusions for the sorption mechanism were deduced. The infrared absorption spectra of various samples of the uranyl phosphates were measured, and the change occurring during the heating was determined. Uranyl hydrogen phosphate was converted to uranyl orthophosphate on heating to 330°C. (auth)

24443 A STUDY ON URANYL PHOSPHATES. III. SOLUBILITY PRODUCTS OF URANYL HYDROGEN PHOSPHATE, URANYL ORTHOPHOSPHATE AND SOME ALKALI URANYL PHOSPHATES. V. Vesely, V. Pekarek, and M. Abbrent (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). J. Inorg. Nucl. Chem., 27: 1159-66(May 1965).

The equations for evaluation of solubility products of uranyl phosphates were derived and the values of solubility products of $UO_2HPO_4 \cdot 4H_2O$, $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ and $MUO_2PO_4 \cdot xH_2O$ (M = Na, K, Rb, Cs, NH_4) were determined. The results obtained were compared with those of others. (P.C.H.)

24444 THE INVESTIGATION OF ADSORPTION PROPERTIES OF PYROCLASTIC ROCKS FOR THE PURPOSES OF RADIOACTIVE WASTE WATER DECONTAMINATION. I. THE CLASSIFICATION OF PYROCLASTIC ROCKS. Zdenek Dlouhy (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 87-91 (Mar. 1965). (In Czech.)

Classification of a great group of natural silicates, pyroclastic rocks, on the basis of their adsorption properties and further criteria for their applicability in radioactive waste water decontamination was carried out. Materials, which maximally met all requirements, were investigated in more details. The best material, rhyodacite tuff from Nižný Hrabovec, was found to be very convenient for radiocesium adsorption from waste waters. The adsorption of radiostrontium under certain conditions [in the absence of calcium ions in treated solutions] may be realized as well. The possibility of the prompt utilization of the above mentioned material in pilot plant or on full operation scale is feasible. (auth)

24445 THE DETERMINATION OF Sr^{90} IN WATER. Jarmila Ralkova (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jaderna Energie, 11: 91-4 (Mar. 1965). (In Czech.)

A rapid control method of ^{90}Sr determination that is appropriate if mainly rapidity and less accuracy are required

is described. The more accurate methods for the determination of ^{90}Sr traces using natural or artificial sorbents are proved on the basis of others' experiences. (auth)

24446 TRACER STUDIES ON THE EXTRACTION OF METAL IONS. 7. EXTRACTION OF Hf, Ta, and W IN THE SYSTEM TETRABUTYL-HYPOPHOSPHATE-TETRABUTYLPYROPHOSPHATE (TBHP–TBPP 1:1)–HF(HCl, HNO_3, $HClO_4$, AND H_2SO_4). J. Mikulski and T. Modro (Inst. for Nuclear Physics, Krakow and Technical Univ., Lodz, Poland). Kernenergie, 8: 102-5(Feb. 1965). (In German)

The extraction process of hafnium, tantalum and tungsten fluorides in the system TBHP-TBPP by means of ^{181}Hf, ^{182}Ta, and ^{185}W was studied. The extraction coefficients of Hf, Ta, and W in hydrochloric and nitric acid solution decrease in the following order of succession: $D_{Hf} > D_{Ta} > D_W$. Hafnium was separated from tantalum and from the rare-earth elements in the system TBHP-TBPP/mineral acid. (auth)

24447 ON THE CONCENTRATION OF THE STABLE ISOTOPE N^{15} BY LIGAND EXCHANGE. D. Schermaul, H. Schuetze, and K. Wetzel (Institut fur Stabile Isotope, Leipzig). Kernenergie, 8: 171-5(Mar. 1965). (In German)

It is shown that, in principle, ligand exchange is suitable for the separation of the stable isotopes of light elements. By using a low-acid cationite in the Cu^{2+} form the isotopic exchange equilibrium $[Cu(^{14}NH_3)_n]^{2+} + {}^{15}NH_3 \rightleftharpoons [Cu(^{14}NH_3)_{n-1}(^{15}NH_3)]^{2+} + {}^{14}NH_3$ is multiplied. To extrude ammonia from resin phase ethylenediamine was used. $^{15}NH_3$ forms a more stable complex with Cu^{2+} than $^{14}NH_3$ and is therefore enriched in resin phase. (auth)

24448 RADIOCHEMICAL SEPARATION OF Tb, Hf AND Th FROM U, Tb FROM Hf AND Pa, AS WELL AS Hf FROM Pa AND W BY REVERSED-PHASE PARTITION CHROMATOGRAPHY IN THE SYSTEM TBP-HCl. I. Stronski (Inst. for Nuclear Physics, Krakow). Kernenergie, 8: 175-8(Mar. 1965). (In German)

The halide mixtures of Tb/U, Hf/U, Th/U, Tb/Hf, Tb/Pa, Hf/Pa, and Hf/W in the TBP-HCl system by reversed-phase partition chromatography were separated. Radioactive tracers were used. (auth)

24449 SEPARATION OF THE TRANSITION ELEMENTS AND ACTINIDES BY MEANS OF ANIONITE AV-17. J. Mikulski and I. Stronski (Inst. for Nuclear Physics, Krakow). Kernenergie, 8: 178-80(Mar. 1965). (In German)

Sorption and desorption conditions of the chlorocomplexes of manganese, iron, cobalt, copper, zinc, thorium, protactinium, and uranium on strongly basic anionite AV-17 were studied using hydrochloric acid of various concentrations as an eluent. The experiments were carried out by means of the radionuclides ^{54}Mn, ^{55}Fe, ^{59}Fe, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{233}Pa, ^{234}Th, and of natural uranium. Mixtures of small amounts of Mn(II), Fe(III), Zn(II) ions, Mn(II), Co(II), Fe(III), Zn(II) ions, and Th(IV), Pa(V), and UO_2(II) ions were separated. (auth)

24450 DETERMINATION OF THE TETRAETHYLLEAD CONTENT OF GASOLINE BY MEANS OF THE ABSORPTION OF BREMSSTRAHLUNG FROM TRITIUM. M. Farkas and P. C. Fodorne. Magy. Kem. Folyoirat, 69: 407-9 (Sept. 1963). (In Hungarian)

A tritium target was used to obtain polychromatic, x-ray-type radiation. The mass absorption coefficients of Cl, Br (α-chloronapthalene, dibromoethane), which are normally present in gasoline, and Pb (tetraethyllead) were determined. Equations were derived for calculating these coefficients, and a calibration curve was charted from which the Pb (tetraethyllead) content could be read. Factors affecting the accuracy of this determination are listed. The method has an accuracy of ±0.04 g of tetraethyllead per liter of gasoline. Much faster determinations are possible with this method but they are costlier and require operators with more preparation. A table compares the accuracy, speed, and cost of the various methods of tetraethyllead determination. (OID)

24451 ACTIVATION ANALYSIS. Maria Oerdoegh and Elek Szabo. Magy. Kem. Lapja, 20: 153-63(Mar. 1965). (In Hungarian)

The general aspects of activation analysis are discussed. The two features, which mainly determine the field of application of this method, are its high sensitivity and rapidity. The latter makes it suitable for use in fast, serial analysis performed usually with the aid of neutron generators. The high sensitivity and rapidity can also be well exploited in reactors. Techniques for activation analysis under development or already developed are described. These include determination of contaminants in graded purity silicon, contaminants in reactor grade uranium compounds, trace amounts of uranium through ^{239}Np, contaminants of biphenyl-diphenylmethane systems, traces of elements in rocks, and impurities in tellurium dioxide. (auth)

24452 RAPID OZONE DETERMINATION NEAR AN ACCELERATOR. G. W. Nederbragt, A. Van der Horst, and J. Van Duijn (Koninklijke Shell-Laboratorium, Amsterdam). Nature, 206: 87(Apr. 3, 1965).

A method for determination of ozone in air (particularly in accelerator target rooms) is described in which the chemiluminescence of ozone in contact with ethylene is used. The results of a check by this method on the efficiency of the ventilation system of a target room are included. (D.C.W.)

24453 HOW TO USE RADIOISOTOPIC YIELD DETERMINATION IN QUANTITATIVE ANALYSIS. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 1, 3p.

Radioisotopic yield determination in quantitative separation of materials is discussed. By this method, the amount of the compound lost in purification can be readily determined. The procedure consists of adding a minute amount of radioactivity labeled compound to the sample containing an unknown amount of the compound, applying the purification step, measuring the amounts of radio activity in the original and purified samples, and determining the amount of the compound to be determined in the purified samples. (M.C.G.)

24454 HOW TO USE RADIOISOTOPIC ANALYSIS FOR MIXING EVALUATION. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 2, 3p.

Measurement of the degree of uniformity of a mixture using radioisotopic analysis is discussed. One of the components is labeled with a radioactive compound and then the radioactivity in aliquots from different regions after or during the mixing process is measured. The radioactivity in each aliquot is compared with the original radioactivity. Advantages of this method are discussed. Examples of this method of mixing evaluation are described. (M.C.G.)

24455 HOW TO USE THE RADIOISOTOPIC DERIVATIVE METHOD IN QUANTITATIVE ANALYSIS. [Norman S. Radin]. Nucl-Chicago Tech. Bull., No. 3, 4p.

When ordinary analytical methods cannot be used because the amount of substance to be determined is very small or because large amounts of substances are present, which interfere in the analysis, the compound to be determined can be converted into a radioactive derivative by reaction with a radioactive reagent. Determination of the radioactive derivative by carrier addition, without addition of carrier, and by addition of labeled carrier is described. Formation of radioisotopic derivatives after separation and addition of labeled derivative to unlabeled derivative mixture are considered. (M.C.G.)

24456 HOW TO USE RADIOACTIVITY IN PAPER CHROMATOGRAPHY. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 4, 4p.

Techniques for the combined use of radioactivity and paper chromatography in analysis are described. Ways to make qualitative identifications starting with radioactive compounds or nonradioactive compounds are discussed Radioactive spots may be quantitatively determined by elution of the spots, by direct counting of the radioactive

spots, by counting randomly cut sections of the paper strip, and by automatic scanning. Uses with unstable elements or compounds are discussed. (M.C.G.)

24457 HOW TO EVALUATE AN ANALYTICAL METHOD WITH THE AID OF RADIOISOTOPES. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 5, 4p.

When an analytical problem can be resolved to a question of completeness of mass transfer or separation, a radioisotope may be used to furnish an answer by tracer techniques. Examples of radioisotopic evaluation in gravimetric analysis by precipitation, extraction, ashing, electrodeposition, distillation, evaporation, sublimation, and chromatographic separation are described. Questions to be considered in planning an evaluation study by this method are listed. (M.C.G.)

24458 HOW TO MAKE QUANTITATIVE DETERMINATIONS BY RADIOMETRIC ANALYSIS. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 6, 4p.

In radiometric quantitative analysis a radioactive compound markedly different in solubility from the original radioactive material is formed. Examples of radiometric analysis described include: titration with formation of a precipitate, use of excess precipitant solution, counting of the precipitate, titration with solvent extraction, and use of an insoluble radioactive indicator. (M.C.G.)

24459 HOW TO PREPARE RADIOACTIVE SAMPLES FOR COUNTING ON PLANCHETS. PARTS 1 AND 2. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 7, 7p.

The effects of geometry, self-absorption, and scattering on G-M counting of beta-emitting samples on planchets are described. Spreading dry powders, preparing nonvolatile liquid samples, and preparing samples with volatile solvents are described. The methods used for handling suspensions of radioactive particles are also described. These include: drying a slurry, centrifuging onto a planchet, and filtering onto a porous planchet. Uses of steel filter planchets are discussed. Precoating, prevention of cracking of the radioactive deposit, prevention of contamination of the filter planchet, and obtaining better deposits are discussed. (M.C.G.)

24460 QUANTITATIVE AND QUALITATIVE ANALYSIS THROUGH NEUTRON ACTIVATION. [C. W. Tittle]. Nucl.-Chicago Tech. Bull., No. 10, 5p.

The principles of activation analysis are outlined. Examples of useful reactions are given. Quantitative relationships, non-uniform neutron flux in the sample, and examples of quantitative analysis by radioactivation are discussed. Neutron sources for activation analysis are described. (M.C.G.)

24461 HOW TO PREPARE SAMPLES FOR LIQUID SCINTILLATION COUNTING. [Norman S. Radin]. Nucl.-Chicago Tech. Bull., No. 11, 3p.

Three basic requirements for good liquid scintillation counting are: the sample must be in good contact with the scintillator, the scintillator must emit a strong flash of light, and the counting mixture must be reasonably transparent to the light flashes. Some ways of meeting these requirements are outlined. Preparation of a simple solution, forcing substances into solution, use of fine suspensions, use of samples impregnated on paper, and suspension of scintillators are described. The problem of colored samples is discussed. (M.C.G.)

24462 CONTINUOUS SCINTILLATION COUNTING OF WEAK BETA EMITTERS IN FLOWING AQUEOUS STREAMS. [K. Piez]. Nucl.-Chicago Tech. Bull., No. 15, 3p.

Steinberg's method for scintillation counting in a two-phase system consisting of a solid, insoluble fluor in contact with an aqueous solution of the radioactive-isotope provided the basis for continuous counting of beta emitters in chromatographic separation. Cell design, counting procedure, data recording, precision and sensitivity, and applications are discussed. (M.C.G.)

24463 SIMULTANEOUS RADIOCHEMICAL DETERMINATION OF ^{85}Sr AND ^{45}Ca BY OXALATE PRECIPITATION METHOD. PART II. DETERMINATION OF STRONTIUM AND CALCIUM. Kiyoshi Kodaira and Rokuro Shinohara (National Inst. of Agricultural Sciences, Tokyo). Radioisotopes (Tokyo), 14: 78-82(Mar. 1965).

A method is described for the simultaneous radiochemical determination of ^{85}Sr and ^{45}Ca. First ^{85}Sr and ^{45}Ca are precipitated together with calcium oxalate in the presence of 15 mg of Ca in 60 ml of solution (250 ppm). Radioactivity of ^{85}Sr is obtained directly from scintillation measurement. Using the conversion factor previously determined for a single radionuclide of ^{85}Sr, the contribution of radioactivity of ^{85}Sr in the sample to G-M counter is estimated. Radioactivity of ^{45}Ca is obtained by subtraction of the estimated counting rate of ^{85}Sr from the total counting rate of G-M measurement. Prior to the establishment of the method, coprecipitation yield of Sr in calcium oxalate was examined in terms of Ca concentration. A range of 0.002 to 1 mg of Sr in 60 ml of solution (0.03–17 ppm) was coprecipitated in calcium oxalate, with the yield of 95.0 ± 0.5% in the presence of 15 mg of Ca (250 ppm), and with lower yields at lower concentrations of Ca. (auth)

24464 ^{14}C AND ^{3}H MEASUREMENT BY THE USE OF A LIQUID SCINTILLATION SPECTROMETER. IV. DETERMINATION OF THE COUNTING EFFICIENCY BY THE DISCRIMINATOR RATIO METHOD. Tetsuo Iwakura, Yosihiko Kasida, and Naoko Morisaki (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 14: 132-6(Mar. 1965). (In Japanese)

A method for the determination of the counting efficiency in liquid scintillation was studied. The ratio of the count rate in two windows that observe different parts of output pulse spectrum vary with quenching degree of scintillator and can be used as an index of the counting efficiency. The spectrometer used was equipped with three discriminators and two scalers. A number of samples containing the same amount of activity of ^{14}C was quenched to various degrees by adding several kinds of solvent as diluter or chemical quencher. In the lower discriminator, A was set to 10 v, and middle and upper discriminators B, C were adjusted, by trial and error, so that the count ratio of one scaler to the another seemed to show linear relationship to the counting efficiency in window A-C. The same procedure was applied to tritium. It was found that several types of quencher, i.e., diluter, mild quencher, and strong quencher, gave the same effect on discriminator ratio-efficiency relation. Recent application of this method to the measurement of natural ^{14}C level in essential oil: p-cymene, is also reported. (P.C.H.)

24465 LIQUID SCINTILLATION COUNTING METHOD OF ETHYLENE-^{14}C. Keishi Shimokawa and Zenzaburo Kasai (Kyoto Univ.). Radioisotopes (Tokyo), 14: 137-41 (Mar. 1965). (In Japanese)

The determination of ethylene-^{14}C evolved by plant tissue using liquid scintillation counter was studied. For the determination of radioactivity, addition of the following scintillation solution to 0.1M methanol solution of mercuric acetate absorbed ethylene-^{14}C gave the highest counting efficiency (59%). Toluene: ethylcellosolve: dioxane (1 : 1 : 1), containing 0.4% PPO, 0.01% POPOP, and 10.0% naphthalene. For the quantitative absorption of ethylene and elimination of $^{14}CO_2$ contamination, the following procedure was adopted. Ethylene-^{14}C evolved by plant tissue was absorbed in 0.25M mercuric perchlorate, from which ethylene was released by addition of 4N lithium chloride, and the ethylene-^{14}C released was reabsorbed by 0.1M methanol solution of mercuric acetate. By adoption of this two step absorption, it was found that the contamination of $^{14}CO_2$ to ethylene-^{14}C could be prevented at a level of 0.02% of total $^{14}CO_2$. (auth)

24466 AN IMPROVED METHOD FOR LIQUID SCINTILLATION COUNTING OF BIOLOGICAL COMPOUNDS IN AQUEOUS SOLUTION. Keiichi Kusama (Shizuoka Univ., Japan). Radioisotopes (Tokyo), 14: 142-5(Mar. 1965). (In Japanese)

For the purpose of measuring aqueous solutions of biological compounds, especially nucleic acids and nucleotides, a very convenient hyamine-water-toluene system

was developed. The composition of the counting mixture is: 10 ml of toluene scintillator (4 grams of PPO, and 0.1 grams of POPOP in 1 liter of toluene), 0.5 ml of 1M hyamine 10-X chloride in ethanol, and up to 0.3 ml of aqueous sample solution. When 1.0 ml of hyamine is added, the system can contain up to 0.4 ml of aqueous solution. Maximum efficiency for ^{3}H is 18.3% and ^{14}C is 53%. Efficiencies of aqueous solutions of ^{3}H- and ^{14}C-UMP, uridine, and uracil were compared with four different solvent systems, that is hyamine-water-toluene, 70% toluene-30% ethanol–PPO–POPOP, dioxane-naphthalene-PPO-POPOP, and so-called Bray solution, at −8 and 10°C. The best results were obtained for the hyamine-water-toluene system. Hyamine Cl 1M in ethanol only has an effect as a solubilizing agent of aqueous solution with toluene scintillator. Commercial 1M hyamine hydroxide in methanol, 1M hyamine Cl in methanol, ½M in ethanol, n-propanol, isopropanol, n-butanol, isobutanol, or ⅔M in n-propanol had no effect at −8°C. Higher alcohol than propanol cannot dissolve hyamine as 1M solution. Quenching per cent for 0.1 ml of 1N HCl, 0.5 N KOH, and 0.5M KCl were 2.5, 6, and 5%, respectively, in the case of 1 ml of 1M hyamine Cl when ethanolic solution was added. Even when 10 mg/0.2 ml of nucleic acid, UMP, uridine solution or, 6 mg/0.1 ml of threonine solution was added, no precipitate or quenching was observed. (auth)

24467 APPLICATION OF THIN LAYER CHROMATOGRAPHY TO THE SEPARATION OF INORGANIC IONS. NOTE I. SCHEME OF THE SEPARATION OF SOME FISSION PRODUCTS. G. Bottura, A. Breccia, F. Marchetti, and F. Spalletti (Universita, Bologna and CNR, Bologna). Ric. Sci., Rend., Ser. A (2), 6: 373-82(Dec. 1964). (In Italian)

Thin layer chromatography of silica gel was applied in the fast separation of mixtures of radioelements, normally components of ^{235}U fission products. The possibility of carrying out separations by bidimensional and by microcolumn techniques is also shown. (auth)

24468 APPLICATION OF N-BENZOYLPHENYLHYDROXYLAMINE TO THE AMPEROMETRIC TITRATION OF CERIUM, THORIUM AND LANTHANUM. V. D. Vasilenko and G. S. Mazharovskaya (Dnepropetrovsk State Univ., Ukrainian SSR). Ukr. Khim. Zh., 31: 101-4(1965). (In Russian)

It was established that cerium(IV) sulfate is titrated by BPGA (N-benzolyphenylhydroxylamine) at pH 1.2 using Pt electrodes and an imposed emf of 0.8 v. Salts of thorium and lanthanum did not interfere with the determination of cerium at ratios of 1:1 and 1:6, respectively. The molar ratio of copper to BPGA was found to be 1:2. The possibility of the indirect determination of thorium and lanthanum by titration of BPGA excess with solutions of copper sulfate was shown. The precipitation of thorium was carried out at pH 4.5 to 5.0 and lanthanum at 8.0. (tr-auth)

24469 ON A NEW SEPARATION LIQUID FOR THE GAS-LIQUID CHROMATOGRAPHY. M. Salzwedel (Kernforschungszentrum, Karlsruhe, Ger.). Z. Anal. Chem., 209: 299-302(1965). (In German)

Radioinduced polymerization of stilbene in presence of a heavy metal catalyst yields a mixture of phenyl-substituted indane derivatives with a melting point of 50–60°C. As the mixture has a very low vapor pressure it was tested as a stationary phase for gas chromatography. The results showed that in connection with a flame ionization detector, it is useful up to 230°C. However, the new stationary phase is of polar character. (auth)

24470 DETERMINATION OF THORIUM IN ZIRCONIUM–HAFNIUM MIXTURES BY AROMATIC POLYCARBOXYLIC ACIDS. Anil K. Mukherji (Louisiana State Univ., New Orleans). Z. Anal. Chem., 209: 321-4(1965).

Results are presented for 1,3,5-benzenetricarboxylic (trimesic), 1,2,4-benzenetricarboxylic (trimellitic), and 1,2,4,5-benzenetetracarboxylic (pyromellitic) acids as precipitants for thorium. Trimesic and pyromellitic acids were found to be better reagents than trimellitic acid. Thorium and zirconium-hafnium mixtures can be separated by precipitating zirconium-hafnium first in 0.5–0.8 N acid solution and then precipitating thorium in the filtrate at 3–4 pH. The separations are quite reproducible. The precipitates in all cases are ignited to the respective oxides. 5–10 mg samples of thorium can be estimated and separated from 10–50 mg samples of zirconium and/or hafnium. Results of investigations on interferences of cations and anions and pyrolysis curves for the decomposition of precipitates are presented. (auth)

24471 RADIOCHEMICAL ANALYSIS: ACTIVATION ANALYSIS, INSTRUMENTATION, RADIATION TECHNIQUES, AND RADIOISOTOPE TECHNIQUES, JULY 1963 TO JUNE 1964. James R. DeVoe, Ed. National Bureau of Standards Technical Note 248. 1964. Washington, D. C., National Bureau of Standards, $0.50(GPO).

Progress in developing techniques for measuring the qualitative, quantitative, and structural composition of materials through the use of radioisotopes is summarized. The research is organized in four sections: radioisotope tracer techniques, activation analysis, radiation techniques, and instrumentation. Facilities and instrumentation are described. Substoichiometric radioisotope dilution analysis, determination of trace amounts of cobalt by substoichiometric radiometric analysis, determination of cobalt by desorption of cobalt hydroxide from hydrous ferric oxide, a drift-free Mössbauer spectrometer, use of a nuclear transformation to measure the surface energy of metals in ultrahigh vacuum, activation analysis of human lung samples, positive sealing with optical coupling of radioactive sources in machined plastic phosphor scintillators, and ion exchange resins are discussed. (M.C.G.)

24472 RADIOCHEMICAL DETERMINATION OF URANIUM IN ENVIRONMENTAL MEDIA BY ELECTRODEPOSITION. Harry Levine and Anthony Lamanna (Public Health Service, Washington, D. C. Div. of Radiological Health). Public Health Service Publication No. 999-RH-11. Mar. 1965. 24p. (Free from USPHS).

Uranium is isolated by either of two techniques: adsorbing on a strongly basic ion-exchange resin pretreated with 6 N HCl, washing with 9 N HCl to remove interfering ions, and eluting with 1 N HCl; or salting with aluminum nitrate, followed by extracting with ethyl acetate and stripping with water. It is then electrodeposited on a nickel-plated copper disc from a dilute ammonium oxalate solution. Electroplating efficiencies are about 85 to 95 percent. A regulated power source connected in parallel permits several electroplating operations to proceed simultaneously. The procedure has been applied to a series of spiked solutions with reproducible results. Maximum deviation is less than 5 percent for any one determination. Beer's law is followed over a range of 10^{-5} to 5.0 g uranium. The method is applicable to samples of biological materials as well as to environmental media. (auth)

24473 INDIRECT METHODS OF ESTIMATING RADIONUCLIDE BODY BURDEN OR EXPOSURE. J. H. Harley (Atomic Energy Commission, New York). p.201-23 of "EUR-2210."

The determination of U, Ra, Rn, Th, Pu, T, mixed fission products, ^{89}Sr, and ^{90}Sr body burdens by analysis of excreta is discussed. An extensive bibliography of 123 references is given. (P.C.H.)

24474 MEASURING OF INTERNAL CONTAMINATION BY SPECTROMETRY. J. Colard (Belgian Nuclear Studies Centre, Mol, Belg.) and J. Henry. p.641-64 of "EUR-2210." (In English and French)

The measurement of internal gamma contamination in man by spectrometry is described. The method is based on the rocking chair technique. The subject of the measurement sits in a chair that holds him in a reproducible position in relation to the detector. The greater part of the body is situated in an arc of approximately 35 cm radius around the crystal. The method of measurement and calibration and sensitivity of the device are described. A model is also described for the ^{131}I metabolism in man. The soundness of the model was confirmed by the results of experiments carried out on 8 persons who had ingested 0.5 μC of ^{131}I each. (P.C.H.)

24475 HIGH-SENSITIVITY COULOMETRIC TITRATOR /Q-2564/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). 24 drawings, 13 Specs. (CAPE-1196)

A coulometric titrator designed and constructed for the accurate determination of small amounts (0.007 μeq to 100 μeq) of high-equivalent weight materials such as $Pu^{4+} + e^- \approx Pu^{3+}$, where one Faraday is equivalent to 239 g of metal, is described. For the titration of 4 μeq of material, or more, the accuracy and precision are comparable to that obtained with Model Q-2005. The performance of this instrument is better than older models for titrations of 0.01 to 4 μeq. The design is based upon three operational amplifiers: the first controls the potential difference between a working (controlled) electrode and a reference electrode; the second furnishes and measures the current flowing through the cell; and the third integrates a known portion of the cell current as a function of time. The output of the last circuit is used as a readout in determining the amount of material oxidized or reduced at the controlled electrode. Readout can be indicated on a chart, XY recorder, or potentiometer. It can be operated as above or by a simple front-panel switching operation and may be used for bench-top or hot-cell operation. (For details, see TID-4100). (D.C.W.)

24476 RF MASS SPECTROMETER PARTIAL PRESSURE ANALYZERS. John B. Hudson (Rensselaer Polytechnic Inst., Troy, N. Y. and General Electric Co., Schenectady, N. Y.). 12p. (CONF-640903-14)

From American Vacuum Society Symposium, Chicago.

Work on quadrupole and monopole spectrometers for measurement of partial pressures in vacuum systems is described. The theory of operation of quadrupole spectrometers is discussed. Experience gained in preliminary studies was used to construct an instrument of the monopole type, with voltage sweeping. Results obtained with this unit were superior to those obtained with either the quadrupole or the earlier monopole designs. The mass range is swept by amplitude modulation of the r-f power supply. With fast sweeping it was possible to display a range of 10 mass numbers at a repetition rate of 10 spectra per second. Resolution and sensitivity appeared to be unaffected by bakeout to 450°C. (M.C.G.)

24477 HEAVY ELEMENTS CONTENT MEASUREMENT BY MEANS OF GAMMA-EXCITED X-RAY FLUORESCENCE. P. Martinelli (Commissariat a l'Energie Atomique, Paris) and P. Blanquet. 21p. (CONF-641017-6)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

Use of radioisotopes as excitation sources in x-ray fluorescence analysis is discussed. The measurement of heavy metal contents by evaluation of their γ-excited characteristic λ x rays is considered. Experimental apparatus and theoretical calculations are described. Application of the method to the determination of lead in powdered mixtures of $PbS-SiO_2-FeS_2-ZnS$ is described. Determinations of tungsten in steel, and Bi, Pb, Hg, and W in aqueous solutions are discussed. (M.C.G.)

24478 DETERMINATION OF GALLIUM IN ROCKS BY NEUTRON ACTIVATION. J.-C. Schiltz (Commissariat à l'Energie Atomique). 18p. (In French). (In French)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

A method for the quantitative determination of gallium in trace amounts in rocks is presented. This method is based on the isolation of the element by paper chromatography and neutron irradiation of the chromatograms. The important problem to be solved is the presence of sodium as major constituent of rocks and as an impurity in paper chromatographs. Sodium gives, on irradiation, an active isotope ^{24}Na, which has almost the same period as that of ^{72}Ga and is much more abundant. Therefore, a chromatographic separation is necessary after washing the paper used. The sensitivity attained is about 10^{-8} g. (tr-auth)

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Refer also to abstract 25051.

24479 (AAEC/TM-279) A TRANSISTORIZED SWITCH FOR KALOUSEK POLAROGRAPHY. H. J. Fraser and T. M. Florence (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan. 1965. 8p. Dep.(mn).

An improved switch was designed for the recording of Kalousek polarograms. The circuit is completely transistorized, and the switching rate can be varied over the range 2.5 to 35 cycles/sec by adjusting a ten-turn helical potentiometer. Frequency stability is better than ±0.5 per cent in the ambient temperature range 0 to 55°C. (auth)

24480 (CNAEM-23) A SPECTROPHOTOMETRIC STUDY OF THE REDUCTION KINETICS OF URANIUM(VI) TO URANIUM(IV) BY MEANS OF HYDROXYMETHANESULPHINIC ACID (RONGALIT). M. Talat-Erben and Esin Oezbora (Cekmece Nuclear Research Center, Atomic Energy Commission, Istanbul (Turkey)). Feb. 1965. 18p. Dep.(mn).

The reduction kinetics of U(VI) to U(IV) by means of hydroxymethanesulphinic acid (Rongalit) were studied in the range 30 to 45°C by measuring the concentration of U(IV) spectrophotometrically. The data conform to a second-second order consecutive reaction in which U(IV) is an intermediate complexing with sulphinic acid which is a reaction product from Rongalit. In nitric acid medium the rate constants decrease with increasing acidity, whereas in perchloric acid medium the rate constants increase with acidity. This behavior is explained by the fact that the NO_3^- ion complexes with both UO_2^{2+} and U^{4+} while the ClO_4^- ion does not complex. The activation energy for the reduction step is about 15 kcal/mole in nitric acid medium and about 17 kcal/mole in perchloric acid medium. The activation energy of the second step is strongly dependent on acidity (6 kcal/mole at 1 M HNO_3, 12 kcal/mole at 1.5 M HNO_3, and 16 kcal/mole at 2 M HNO_3). The activation energy of the second step is independent of the acidity in perchloric acid medium and is almost equal to the activation energy of the reduction step. (auth)

24481 (GAT-T-1141) ANALYSIS OF HIGH-PURITY URANIUM METAL. F. S. Voss and C. F. Trivisonno (Goodyear Atomic Corp., Piketon, Ohio). Dec. 20, 1963. Contract AT(33-2)-1. 7p. Dep.(mn); $1.00(cy), 1(mn)CFSTI.

A sample of high-purity, depleted U metal was analyzed for impurities. The following results were obtained (μg/g sample): Cr 1.6, Cu 3.7, F 1.3, Fe 15.8, Mn 5.5, Mo 0.1, Ni 8.5, P < 1.0, Si 1.2, Th < 1.0, Ti < 0.5, W < 1.0, V < 0.5, and Zn 17.6. (D.L.C.)

24482 (IS-1061) REACTIONS OF URANIUM CARBIDE IN A FUSED KCl–LiCl/ZINC SYSTEM. William C. Robinson, Jr., and Premo Chiotti (Ames Lab., Iowa State Univ. of Science and Tech.). Nov. 1964. Contract W-7405-eng-82. 112p. Dep.; $4.00(cy), 3(mn) CFSTI.

The reaction of uranium monocarbide with liquid zinc was investigated in the temperature range of 540–800°C. At temperatures below 725°C, the uranium monocarbide reacts with the liquid zinc to form a uranium–zinc compound and an oxygen-enriched uranium monocarbide phase. There is no reaction at 800°C. This indicates that the standard free energy of formation of uranium monocarbide is equal to the free energy of $UZn_{8.5}$ at about 725°C. No other uranium carbide phase is ever observed as a reaction product. The reactions of uranium monocarbide in a $LiCl-KCl-ZnCl_2$/zinc system are investigated in the temperature range 580–802°C. The salt phase is analyzed for uranium and zinc and the mole fraction ratio $K_N = N_{UCl_3}/(N_{ZnCl_2})^{\frac{1}{3}}$ is calculated. The K_N proves to be a function of the moles $ZnCl_2$/moles UC charged with the uranium remaining in the zinc phase present as an oxygen-enriched uranium monocarbide at values of K_N greater than 20 and as UO_2 at values of K_N less than 15. All of the uranium in the uranium monocarbide charged is never oxidized into the salt even when K_N's as low as 0.21 are obtained. These results indicate that the

uranium monocarbide lattice is being stabilized by oxygen. An emf cell of the type $U/LiCl-KCl-UCl_3/UO_xC_{1-x}$, C was utilized to investigate the increase in chemical potential of uranium in the uranium oxycarbide phase as a function of oxygen composition from 0.35 to 0.82 mole fraction UO and temperature from 460 to 760°C. Extrapolation of the data obtained to zero oxygen concentration is shown to yield the free energy of formation of UC as a function of temperature. The equation obtained is $\Delta F^\circ_{UC} = -16{,}915 - 1.90T$. (auth)

24483 (IS-1122) STABILITY CONSTANTS OF THE TRIVALENT LANTHANONS WITH SOME ALPHA-HYDROXYCARBOXYLIC ACIDS. George S. Paul and Jack E. Powell (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 85p. Dep.; $3.00 (cy), 2(mn) CFSTI.

The first three stepwise formation constants of the 2-hydroxy-3-methylbutanoate (isopropylglycolate), 2,3-dimethyl-2-hydroxybutanoate (methylisopropylglycolate), 3,3-dimethyl-2-hydroxybutanoate (tertiary-butylglycolate), and 2-hydroxy-2,3,3-trimethylbutanoate (methyltertiary-butylglycolate) complexes of the trivalent rare earths and yttrium were determined at 25°C and an ionic strength of 0.1 molar ($NaClO_4$). The stabilities of the complexes followed the ionic radius trend quite regularly. The stabilities generally decreased with increasing complexity of the alkyl substituents on the ligand, but replacing a hydrogen atom by a methyl group invariably enhanced the stabilities of the complexes, especially in the case of the heavier, smaller rare-earth ions. It was postulated that the stabilities of the heavier rare-earth complexes with the methyl-substituted homologues were enhanced because of a smaller, more favorable hydroxyl-carboxyl bond angle. (auth)

24484 (IS-T-11) OXIDATION STATES OF THORIUM IN FUSED LiCl–KCl EUTECTIC (thesis). Charles Harvey Dock (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 90p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

The compounds $ThCl_3$ and $ThCl_2$ were prepared by the reduction of $ThCl_4$ with thorium. X-ray powder patterns were taken of the $ThCl_3$ and $ThCl_2$ and also of $ThOCl_2$. The d spacings calculated from the powder patterns of these compounds are tabulated. Thermal data obtained from equilibrated Th–$ThCl_4$ mixtures are consistent with the existence of $ThCl_3$ and $ThCl_2$ and are used in constructing a tentative phase diagram. The data indicate that $ThCl_3$ disproportionates to $ThCl_4$ and $ThCl_2$ at 698°C, and that $ThCl_2$ decomposes peritectically at 748°C. The data indicate negligible mutual solid solubility among these compounds. Glassner's relations for the standard free energies of formation for $ThCl_4$ and $ThCl_3$ were simplified to $\Delta F^\circ_{ThCl_4} = -286{,}400 + 129.2T - 19.3T \log T$ cal/mole and $\Delta F^\circ_{ThCl_3} = -231{,}800 + 96.9T - 13.8T \log T$ cal/mole. A reasonable expression for $\Delta F^\circ_{ThCl_2}$ was found to be $\Delta F^\circ_{ThCl_2} = -172{,}900 + 62.9T - 9.2T \log T$ cal/mole. Electromotive force measurements of the cell Th/LiCl–KCl–$ThCl_4$/LiCl–KCl–3.3 wt % AgCl/Ag indicate that the activity coefficient of $ThCl_4$ relative to the pure solid in LiCl–KCl eutectic is about 1×10^{-3} for the concentration range 0.1 to 32.4 wt % $ThCl_4$ in the salt and the temperature range 450–650°C. The activity coefficient of $ThCl_3$ relative to pure solid $ThCl_3$ is assumed to be unity in the LiCl–KCl eutectic. Experimental data of equilibrations of $ThCl_4$ in LiCl–KCl with thorium metal indicate that the activity coefficient of $ThCl_2$ relative to the pure solid in LiCl–KCl is about 1×10^3 at 700°C. From these values of the activity coefficients of the thorium chloride the LiCl–KCl eutectic and the free energy data for these thorium chlorides and the thorium–zinc compound, Th_2Zn_{17}, the expected extents of the reactions $ThCl_4$ (in LiCl–KCl) + $\frac{1}{6}$ Th_2Zn_{17}(s) → $\frac{4}{3}$ $ThCl_3$ (in LiCl–KCl) + $\frac{17}{6}$ Zn(l) and $ThCl_4$ (in LiCl–KCl) + $\frac{1}{2}$ Th_2Zn_{17}(s) → $2ThCl_2$ (in LiCl–KCl) + 8.5 Zn(l) are calculated. Experimental results of equilibrations of solutions of $ThCl_4$ in LiCl–KCl with Th_2Zn_{17} in zinc agree well with predictions that the predominant thorium chlorides in solution are $ThCl_4$ and $ThCl_3$, with the relative amounts of each depending on total thorium concentration in the salt and on temperature. It is found that higher ratios of the mole fraction of $ThCl_3$ to the mole fraction of $ThCl_4$ are favored by lower total thorium concentration in the salt and by higher temperature. (auth)

24485 (JINR-P-2001) IZUCHENIE KOMPLEKSOOBRAZOVANIYA KYURIYA I EVROPIYA EKSTRAKTSIONNYM METODOM. (Investigation of Complexes of Curium and Europium Using Solvent Extraction). I. Stary (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1965. 8p. Dep.(mn).

On the basis of an investigation of extraction of curium and europium with thenoyltrifluoracetone in benzene, the extraction constants have been determined (log K = −7.30 for Cm and log K = −7.18 for Eu). Further, composition and stability constants were determined for complexes of curium and europium with tartaric acid (log β_2 = 6.84 for Cm and log β_2 = 6.79 for Eu), with oxalic acid (log β_2 = 8.8 and log β_3 = 12.1 for both Cm and Eu); with nitrilotriacetic acid (log β_2 = 20.13 for Cm and log β_2 = 20.42 for Eu), with ethylenediamintetraacetic acid (log β_1 = 17.10 for Cm and log β_1 = 17.34 for Eu) and with 1,2-diaminocyclohexanetetraacetic acid (log β_1 = 18.35 for Cm and log β_1 = 18.51 for Eu). From the results obtained, it follows that the stability of complexes of curium is higher than those of americium, but it is lower than the stability of corresponding complexes of europium. (auth)

24486 (LA-3252) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. III. TUNGSTEN. D. F. Bowersox and J. A. Leary (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 1, 1964. Contract W-7405-eng-36. 12p. Dep.; $1.00(CFSTI).

The solubility of tungsten in liquid plutonium was measured over the temperature range 700 to 1000°C. The solubility increased from 29 ppm (by weight) W at 700°C to 291 ppm W at 950°C. The data fit the empirical equation $\log N_W = 0.3518 - 4.639 \times 10^3\ T^{-1}$, where N_W is the solubility expressed as the mole fraction of W, and T is the temperature in degrees Kelvin. (auth)

24487 (ORNL-3804) RARE-EARTH HALIDES. R. E. Thoma (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 59p. Dep.; $3.00(cy), 2(mn) CFSTI.

A review is presented of the chemistry of the anhydrous rare-earth halides. Topical emphasis is placed on the current state of chemical development in this field, preparation and purification methods, properties of the simple halides, the oxyfluorides, rare-earth metal-trihalide systems, complex halides, phase diagrams, and absorption spectra. Tabular data are included which summarize the currently available data on physical properties, oxidation potentials, crystallographic properties, and phase equilibria. (auth)

24488 (TID-21840) THE SECOND-ORDER THEORY OF CONFORMAL SOLUTIONS USING THE MORSE POTENTIAL FUNCTION. Osamu Yoshikawa (Delaware Univ., Newark. Dept. of Chemical Engineering). Aug. 22, 1964. Contract AT(30-1)-2722. 143p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Application of the Morse potential function to conformal solution theory, which is based on the law of corresponding states, is made and the results are investigated in comparison with the observed values of the excess Gibbs free energy of mixing for 26 binary metallic mixtures and some organic mixtures. Along with the above calculation, the applicability of the law of corresponding states is tested by the calculation of the difference of the configurational Gibbs free energy of the two pure substances concerned. It is shown that the existing controversy about the misfit energy due to the molecular size difference in a mixture can not adequately be discussed using the 6-12 Lennard-Jones potential function. The concept of relaxation of the misfit energy was proposed by introducing the new idea of cell deformation, which enables one to calculate the degree of the relaxation from a knowledge of statiç displacements in a lattice, and its crude model was used for further calculations. Also, the theory was extended to multicomponent systems and compared with the cell theory of solutions. Deviation from the Berthelot relation was observed in most of the metallic systems used and its relation to

other physical factors, such as electronegativity, was investigated by regression analysis. It was concluded that this second-order conformal solution theory, allowing for cell deformation, will be very useful to the many metallic systems as well as non-polar, spherical, organic systems, if a more accurate method to estimate the deviation from the Berthelot relation and the magnitude of the static displacements can be obtained. The possible advantages of the prinicpal-components method to regression analysis and the use of a modified Monte Carlo method to the calculation of the canonical average of a thermodynamic function of a system were investigated. Also, for the representation of excess thermodynamic properties, especially in a ternary field, the superiority of the equation proposed by Wohl is demonstrated. The advantages of orthogonalizing the terms in this representation are shown. (auth)

24489 (UCRL-12314) VOLATILITIES OF THE FISSION PRODUCT AND URANIUM OXIDES. Ray G. Bedford and Donald D. Jackson (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 20, 1965. Contract W-7405-eng-48. 39p. Dep.; $2.00(cy), 1(mn) CFSTI.

Free energies of oxides were compiled and used to calculate at several temperatures from 500 to 2500°K the equilibrium abundances of the gaseous oxides of the elements between atomic numbers of 32 and 62, and of uranium. The equivalent pressures of fission products are plotted for 1500 and 2500°K and oxygen pressures 1 and 10^{-10} atm. (D.L.C.)

24490 X-RAY POWDER DIFFRACTION STUDY OF THE $WO_3 \rightleftharpoons W_{20}O_{58}$ SHEAR TRANSFORMATION. P. Gado (Inst. for Telecommunication Technique, Budapest). Acta Phys. Acad. Sci. Hung., 18: 111-17(1965).

By means of continuous high-temperature diffractometry the shear model of the crystallographic transformation $WO_3 \rightleftharpoons W_{20}O_{58}$ was experimentally studied. Solid-state reaction in the range 500 to 600°C results in defective beta-tungsten-oxide structures, the shear between adjacent blocks being random instead of parallel-equidistant. A difference was established between the mechanism of reduction and oxidation. (auth)

24491 NEW POSSIBILITIES OF THE THERMOBALANCE IN THE INVESTIGATION OF GAS-SOLID REACTIONS. I. Stamenkovic and I. Blagojevic. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 287-91(Oct. 1964).

An improved thermobalance is described with which the kinetics of powder oxidation of UO_2 to U_3O_7 was investigated. The thermo-balance was also used to develop a thermal method of determining the atomic ratio of O/U. (D.C.W.)

24492 ESTIMATION OF THE STANDARD ENTROPY OF U_3O_7. I. Stamenkovic. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 293-5(Oct. 1964).

The standard entropy of UO_2, UO_3, U_3O_7, and U_3O_8 at 298.1°K was calculated using Kelley's equation. The results for UO_2, UO_3, and U_3O_8 were compared with experimental values; good agreement was obtained. (D.C.W.)

24493 INFRARED ABSORPTION OF DEUTERIUM INDUCED BY INTERMOLECULAR FORCES. S. Paddi Reddy and C. W. Cho (Memorial Univ. of Newfoundland, St. John's). Can. J. Phys., 43: 793-9(May 1965).

The pressure-induced fundamental infrared absorption band of deuterium was investigated in the pure gas for gas pressures up to 250 atm at room temperature. The binary and ternary absorption coefficients were determined from the integrated absorption coefficients of the fundamental band at different densities of the gas. The splitting of the Q branch into two well-resolved components Q_P and Q_R was observed; the contours also exhibited pronounced S(0) and S(2) components with an indication of the S(1) and O(2) components. The existing theory and the available molecular parameters of deuterium were used to calculate the binary absorption coefficients of the individual lines of the O and S branches and of the quadrupole part of the Q branch. From these calculations and the experimental value of the total binary absorption coefficient of the fundamental band, the overlap part of the binary absorption coefficient of the Q branch was estimated. (auth)

24494 PRESSURE-INDUCED INFRARED ABSORPTION OF GASEOUS HYDROGEN AND DEUTERIUM AT LOW TEMPERATURES. I. THE INTEGRATED ABSORPTION COEFFICIENTS. A. Watanabe and H. L. Welsh (Univ. of Toronto). Can. J. Phys., 43: 818-28(May 1965).

The pressure-induced infrared absorption of the fundamental band of hydrogen, in the pure gas and in a H_2–He mixture, and of deuterium was studied in the temperature range from 18 to 77°K. Path lengths up to 13.6 m at 1 atm or somewhat higher were obtained in a multiple-traversal cell cooled by liquid hydrogen or nitrogen. The binary coefficient $\tilde{\alpha}_1$ for hydrogen showed a rise at low temperature, indicating the existence of bound states predicted by theory for the $(H_2)_2$ complex. The effect was more pronounced for deuterium. For the H_2–He mixture $\tilde{\alpha}_1$ decreased monotonically with temperature, thus showing no evidence of bound states for H_2–He pairs. Fine structure at the maxima of the pressure-induced band in hydrogen and deuterium gave direct spectroscopic evidence of bound states of $(H_2)_2$ and $(D_2)_2$ complexes at low temperatures. (auth)

24495 THE PREPARATION OF CERIUM THIOIODIDE CeSI. Christian Dagron (Laboratoire de Chimie Minerale de la Faculte de Pharmacie, Paris). Compt. Rend., 260: 1422-4(Feb. 1, 1965). (In French)

Cerium was combined progressively with iodine and then with sulfur and CeSI was obtained at 500°C. Further heating for several weeks at 850°C in fused cerium iodide made it possible to obtain monocrystals reaching several millimeters in size. The purity of the product was controlled by analyses. The crystalline lattice was orthorhombic with parameters $\underline{a}$ = 7.35, $\underline{b}$ = 14.42, and $\underline{c}$ = 7.06 Å. The density measured at 0°C was 5.35. (tr-auth)

24496 STUDY OF THE PRECIPITATION OF MIXED URANIUM–THORIUM OXALATES. Guy Brau, Rene Bressat, Bernard Claudel, Yves Trambouze, and Henri Urbain (C.N.R.S., Villeurbanne, France). Compt. Rend., 260: 1981-3(Feb. 15, 1965). (In French)

When oxalic acid is introduced into a solution of thorium nitrate and uranium(IV) nitrate, a mixed oxalate $U_xTh_{1-x}(C_2O_4)_2 \cdot nH_2O$ is obtained. However, under such conditions, x varies during the precipitation. On the contrary, the addition of the solution of nitrates to a saturated oxalic solution makes it possible to prepare homogeneous mixed oxalates. (tr-auth)

24497 CONTRIBUTION TO THE STUDY OF A COMPLEX FLUORIDE OF PENTAVALENT URANIUM AND AMMONIUM THERMAL DECOMPOSITION. Nguyen-Nghi, Albert-Jose Dianoux, Hubert Marquet-Ellis, and Pierre Plurien (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 260: 2229-32(Feb. 22, 1965). (In French)

The various experimental techniques used (differential thermal analysis, thermogravimetry, chemical analyses, radiocrystallography, and the analysis of gas by infrared spectrophotometry and by microsublimation) indicate without ambiguity that NH_4UF_6 is decomposed beginning at 150°C by giving UF_4 and releasing fluorine and ammonium fluoride. There is no release of UF_6. (tr-auth)

24498 A NEW FAMILY OF CHEMICAL COMPOUNDS OF THE RARE EARTHS, THE OXYDISULFIDES, WITH THE GENERAL FORMULA $L_2O_2S_2$. Parviz Khodadad, Tat Tek, Jean Flahaut, and Louis Domanae (Faculte de Pharmacie, Paris). Compt. Rend., 260: 2235-8(Feb. 22, 1965). (In French)

Compounds with the formula $L_2O_2S_2$ were obtained by the action of sulfur vapor in sealed ampules on the oxysulfide or the mixture 2 L_2O_3 + L_2S_3. The attack by diluted acid under vacuum displaced half the sulfur in the elementary state and half in the hydrogen sulfide state. The crystalline lattice was quadratic and the lattice cell contained two molecules. These products existed only with La, Pr, and Nd. With Ce, a product with different composition and structure,, but possessing the same chemical behavior, was obtained. (tr-auth)

24499 THE THERMOCHEMISTRY OF CERIUM(IV) NITRATE EXTRACTION WITH TRIBUTYL PHOSPHATE.

A. V. Nikolaev, Yu. A. Afans'ev, A. I. Ryabinin, and T. I. Koroleva (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 159: 851-2(Dec. 1, 1964). (In Russian)

The heats of dissolution of $Ce(NO_3)_4 \cdot 5H_2O$ (solid) in water and TBP were measured calorimetrically at 25°C. A value of $\Delta H_1 = 12.34$ kcal/mole was found for infinite dilution in water, and a value of $\Delta H_2 = -13.42$ kcal/mole was found for infinite dilution of $Ce(NO_3)_4 \cdot 5H_2O$ (solid) in TBP. Hence, the thermal effect for the reaction $Ce(NO_3)_4$ (aqueous) + 2 TBP → $Ce(NO_3)_4 \cdot 2$ TBP (liquid) can be computed to be equal to $\Delta H_3 = \Delta H_2 - \Delta H_1 = -25.76$ kcal/mole. Analogous experiments with the basic cerium(IV) nitrate salt $Ce(OH)(NO_3)_3 \cdot 3H_2O$ gave a value of $\Delta H_3 = \Delta H_2 - \Delta H_1 = -13.39 - 7.13 = -20.52$ kcal/mole. Direct calorimetric measurements of the heat of extraction of cerium(IV) nitrate by TBP are in agreement with the above calculated values. The heat of mixing ΔH of $Ce(OH)(NO_3)_3 \cdot 2TBP$ with TBP at 25°C varied from −174 kcal/mole of solution at a TBP mole fraction of 0.818 to a maximum of ~−400 kcal/mole of solution at a TBP mole fraction of ~0.4. (TTT)

24500 STUDIES ON EDTA COMPLEXES. PART III. IRON(III)-EDTA AND CERIUM(IV)-EDTA SYSTEMS. T. R. Bhat and D. Radhamma (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 3: 151-4(Apr. 1965).

Cerium (IV)-EDTA and iron (III)-EDTA systems were investigated spectrophotometrically. The values of formation constants for CeY and FeYH obtained were $10^{24.2}$ and $10^{15.15}$, and those for CeY $(OH)^-$ and $FeY(OH)^{2-}$ (from the normal complex) were $10^{11.16}$ and $10^{7.07}$ respectively at 25 ± 1°C and ionic strength 1. Cerium-EDTA complex was unstable and its decomposition rate obeyed the first order rate law. The rate constant was pH dependent, being proportional to $[H^+]^{2.5}$ at pH < 1 and to $[H^+]^{0.125}$ at pH < 1.5. (auth)

24501 PREPARATION AND CRYSTALLOGRAPHIC STUDIES OF STRONTIUM PLUTONATE. D. M. Chackraburtty and N. C. Jayadevan (Atomic Energy Establishment, Trombay, India). Indian J. Phys., 38: 585-6(Nov. 1964).

Strontium carbonate was heated to its oxide, which was mixed with freshly prepared plutonium dioxide in the ratio necessary for the formation of $SrPuO_3$ and finally heated to 1300–1500°C in a resistance furnace. Diffraction patterns of the sample were taken, and the lines were indexed on the basis of the orthorhombic cell derived from the monoclinic cell, and from consideration of the symmetrical lattice obtained. Spectrophotometric studies indicated the valency of plutonium in IV state, hence it was concluded that strontium plutonate with a molecular formula $SrPuO_3$ was a complex-oxide system in the group of perovskite compounds. (L.B.S.)

24502 DIFFUSION COEFFICIENTS OF THE SYSTEMS He–T_2 AND He–TH. I. Amdur and A. P. Malinauskas (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 42: 3355-60(May 15, 1965).

Binary mutual diffusion coefficients were measured for the systems He–T_2 and He–TH by a radioactive tracer method at four temperatures in the range 195 to 374°K. The results, reduced to one atmosphere and normalized to the system He–H_2, can be expressed within an average deviation of slightly less than 1% by the empirical relations He–T_2: $\log_{10}D = 1.6599 \log_{10}T - 3.9230$, and He–TH: $\log_{10}D = 1.6960 \log_{10}T - 4.0140$. The ratio of the normalized coefficients for He–T_2 and He–TH show a small departure from unity, starting at 1.02 at the lowest temperature and decreasing smoothly to 0.996 at the highest. On the assumption that deviations from classical mechanics, contributions from internal degrees of freedom, and the effects of asymmetric force fields are the same, or negligibly small, for both systems, different sets of Lennard-Jones (12-6) potential parameters were obtained that correlate the experimental results as well as the empirical equations. (auth)

24503 DIFFUSION COEFFICIENTS OF HYDROGEN ISOTOPES. I. Amdur and J. W. Beatty, Jr. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 42: 3361-4 (May 15, 1965).

Binary mutual diffusion coefficients were measured by a radioactive tracer method for the following systems: H_2-T_2 and D_2-T_2 at 195, 273, and 353°K; H_2–TH and D_2–TH, at 195 and 273°K. The ratios of the normalized coefficients for H_2-T_2 relative to H_2–TH and for D_2-T_2 relative to D_2–TH show the same trend as that previously reported for He–T_2 relative to He–TH. In the present case both ratios are slightly greater than unity at 195°K and slightly less than unity at 273°K. A larger isotope effect, produced by the substitution of D_2 for H_2, is reflected in the normalized coefficients for D_2-T_2 relative to H_2-T_2 and for D_2–TH relative to H_2–TH. The average values of these ratios are about 2% greater than unity at the lowest temperature and about 5% greater than unity at the higher temperatures. (auth)

24504 DIFFUSION COEFFICIENTS OF T_2-H_2 AND T_2-D_2: THE NONEQUIVALENCE OF THE H_2 AND D_2 CROSS SECTIONS. E. A. Mason, B. K. Annis, and M. Islam (Univ. of Maryland, College Park). J. Chem. Phys., 42: 3364-6(May 15, 1965). (IMP-AEC-30)

Measurements of diffusion in T_2-H_2 and T_2-D_2 in three apparatuses of the two-bulb type are reported at 295.0°K. The ratios of the diffusion cross sections are 1.024 ± 0.014, 1.018 ± 0.011, and 1.015 ± 0.011 in the three apparatuses. This confirms, within mutual experimental error, the observations of others. The average diffusion coefficients at 1 atm, corrected to a reduced mass equivalent to H_2-H_2 diffusion, are 1.441 cm^2/sec from the T_2-H_2 measurements and 1.469 cm^2/sec from the T_2-D_2 measurements. (auth)

24505 DIRECT OBSERVATION OF THE DECOMPOSITION OF MULTIPLY CHARGED IONS INTO SINGLY CHARGED FRAGMENTS. K. E. McCulloh, T. E. Sharp, and H. M. Rosenstock (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 3501-9(May 15, 1965).

A new technique was developed for the direct observation of the decomposition of multiply charged polyatomic ions. Positive ions or ion pairs and ejected electrons, formed in a uniform electrostatic field by a 1-kev electron beam, are accelerated in opposite directions to multiplier detectors. The masses of the positive ions are determined by measuring the time interval between electron and ion pulses by delayed coincidence. The formation of positive ion pairs is demonstrated and their masses determined by electron–ion–ion delayed coincidence techniques. The effects of initial kinetic energy on mass-spectrum peak shapes and travel time correlations between members of an ion pair are discussed. Both of these effects are experimentally observed. The technique was applied to the study of ionization and fragmentation of CO_2, CF_4, CH_4, and C_3H_6. Numerous decompositions leading to the formation of positive ion pairs are observed. Significant fractions of particular high-kinetic-energy fragment ions are formed by these processes. (auth)

24506 SURFACE IONIZATION OF NIOBIUM. Milton D. Scheer and Joseph Fine (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 3645-8(May 15, 1965).

By measuring the temperature dependence of Nb^+ emission from a niobium surface heated between 1990 and 2175°K; a value of 10.39 ± 0.15 ev was obtained for the heat of ion vaporization. The work function for the niobium surface was found to be 3.90 ± 0.05 ev in the 1850-to-2025°K temperature range. The method used for this determination consisted of a mass-spectrometric measurement of the ratio of positive to negative ions formed when a constant-intensity beam of alkali halide molecules impinged upon the niobium surface. These quantities, together with the ionization potential of niobium are sufficient to derive a value of 7.45 ev for the heat of niobium sublimation at absolute zero. This is in excellent agreement with previous direct determinations of this quantity. (auth)

24507 MEASUREMENT OF THERMAL DIFFUSION AND DETERMINATION OF THE INTERMOLECULAR

POTENTIAL OF GASEOUS URANIUM HEXAFLUORIDE. P. Kirch and R. Schuette (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrums, Karlsruhe, Ger.). J. Chem. Phys., 42: 3729-30(May 15, 1965).

Experiments on the thermal diffusion of gaseous UF_6 were carried out at various temperatures and gas pressures in a 3-m-long thermal diffusion column made of concentric nickel tubes having a distance of 4 mm between the hot and the cold wall. The separation effects given by $q-1 = [n_t(1-n_b)/n_b(1-n_t)]-1$ (n_t, n_b are the mole fractions of $^{235}UF_6$ at the top and the bottom of the column, respectively) were found to be in the range of 5×10^{-4} to 4×10^{-3} and were measured with a relative accuracy of about ±5%. The experimental values for the thermal diffusion factor α of gaseous UF_6 are plotted vs the absolute temperature T. For the completely specified intermolecular potential all transport coefficients and the second virial coefficient of gaseous UF_6 were calculated as functions of temperature. Within the available experimental data given by others, the results show complete agreement between theoretical and measured values of viscosity, thermal conductivity, self-diffusion, and also with experimental values of the non-ideality parameter of gaseous UF_6. (P.C.H.)

24508 BIS-(DISUBSTITUTEDPHOSPHINYL)-ALKANES. III. CRYSTALLINE COMPLEXES OF BIS-(DI-2-ETHYLBUTYLPHOSPHINYL)-METHANE AND BIS-(DICYCLOHEXYLPHOSPHINYL)-METHANE WITH URANIUM(VI) NITRATE AND WITH THORIUM NITRATE. J. R. Parker and C. V. Banks (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 583-7(Mar. 1965). (IS-850)

Bis-(di-2-ethylbutylphosphinyl)-methane (EBDPM) and bis-(dicyclohexylphosphinyl)-methane (CHDPM) were found to form the following crystalline complexes: $UO_2(NO_3)_2 \cdot$ EBDPM, $2Th(NO_3)_4 \cdot 3$EBDPM, $UO_2(NO_3)_2 \cdot$ CHDPM and $Th(NO_3)_4 \cdot$ CHDPM. The nitrates are coordinated and the ligands are probably bidentate. These complexes have high thermal stability. (auth)

24509 BAND EMISSION OF GADOLINIUM TRICYCLOPENTADIENIDE AND LANTHANUM TRICYCLOPENTADIENIDE. R. Pappalardo and S. Losi (Cyanamid European Research Inst., Cologny, Switzerland). J. Inorg. Nucl. Chem., 27: 733-5(Mar. 1965).

Rare earth cyclopentadienides were obtained by the reaction of sodium cyclopentadienide with rare earth chlorides in tetrahydrofuran. The gadolinium compound was characterized by a strong, green fluorescence and the lanthanum compound by a weaker, yellow fluorescence. (M.C.G.)

24510 TERNARY OXIDES OF TRI- TO SEPTIVALENT TECHNETIUM WITH ALKALIS. C. Keller and B. Kanellakopulos (Technische Hochschule, Karlsruhe, Ger. and Institut fur Radiochemie, Gesellschaft fur Kernforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 787-95(Apr. 1965). (In German)

In the system alkali oxide–technetium oxide–oxygen the following ternary oxides were prepared by solid state reactions: Li_5TcO_6, Na_3TcO_3, Na_5TcO_6, and K_3TcO_5 with heptavalent technetium; α-Li_4TcO_5, β-Li_4TcO_5, α-Li_6TcO_6, and β-Li_6TcO_6 with hexavalent technetium; α-Li_3TcO_4 β-Li_3TcO_4, and $NaTcO_3$ with pentavalent technetium; Li_2TcO_3, Na_2TcO_3, and Na_4TcO_4 with tetravalent technetium as well as $NaTcO_2$ with trivalent technetium. Most of these compounds are isotypic with the corresponding ternary oxides of rhenium. Chemical and structural properties of the ternary oxides are discussed and compared with those of the corresponding compounds of rhenium and manganese. (auth)

24511 FLUORITE PHASES IN THE SYSTEMS PROTACTINIUM PENTOXIDE-RARE EARTH OXIDE. C. Keller (Technische Hochschule, Karlsruhe, Ger. and Institut für Radiochemie, Gesellschaft für Kernforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 797-800(Apr. 1965). (In German)

The ternary oxides of the composition $(Me^{III}_{0.5}, Pa^{V}_{0.5})O_2$ (Me = La, R.E., Act.) show great solubility for the corresponding Me(III)-oxides. The solubility of $MeO_{1.5}$ in $(Me_{0.5}, Pa_{0.5})O_2$ at 1250°C decreases proportional to the lattice constant of the cubic compound $(Me_{0.5}, Pa_{0.5})O_2$ and increases with the reaction temperature. Furthermore a fluorite phase was found on the $PaO_{2.5}$-rich part of the system $PaO_{2.5}$–$MeO_{1.5}$. There is a formation of complete mixed crystals in the system ThO_2–$PaO_{2.5}$, at least up to 1000°C. (auth)

24512 CHEMISTRY OF THE M8 ELEMENTS AND ELECTRONEGATIVITY. R. T. Sanderson (Arizona State Univ., Tempe). J. Inorg. Nucl. Chem., 27: 989-92(May 1965).

Covalent radii of the M8 elements were obtained by extrapolation and used in estimating electronegativities of Ne 4.37, Ar 3.92, Kr 3.17, and Xe 2.62. Bond polarities were estimated using these values, and bond lengths were calculated to be in reasonably good agreement with those derived by experimental methods. The chemical significance of electronegativity in these elements is discussed, together with the compactness method of electronegativity evaluation. (auth)

24513 HYDROLYSIS OF THORIUM CARBIDES BETWEEN 25 AND 99°C. M. J. Bradley and L. M. Ferris (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 1021-36(May 1965). (ORNL-P-726)

The reactions with water of arc-cast thorium carbides with total–C/Th atom ratios varying from 0.8 to 2.1 were investigated. Thorium monocarbide produced mostly methane (and also hydrogen if carbon-deficient). Thorium dicarbide yielded C_2– to C_3–hydrocarbons, hydrogen, and a nonvolatile wax. Varying the reaction temperature between 25 and 99°C caused no change in the hydrolysis products, although the reactions were considerably faster at the higher temperatures. Hydrolysis of monocarbide–dicarbide mixtures gave the products expected from simple ThC–$ThC_{1.95}$ binaries. Tungsten (2.4 at. %) as an impurity in thorium dicarbide catalyzed the polymerization of the C_2 units to wax which markedly changed the gas composition. The maximum combined–C/Th atom ratio obtainable by arc-melting with graphite electrodes was 1.95 rather than the theoretical 2.00. There was no indication of any significant range of composition for the dicarbide. The lattice parameter for $ThC_{1.0}$ was 5.346 Å, and for the carbon-deficient $ThC_{0.8}$ 5.340 Å. (auth)

24514 MICROCALORIMETRIC DETERMINATION OF THE ENTHALPY OF FORMATION OF THE COMPLEX IONS OF TRIVALENT PLUTONIUM, AMERICIUM AND LANTHANUM WITH EDTA. J. Fuger and B. B. Cunningham (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 27: 1079-84(May 1965). (UCRL-11596)

The heats of solution of anhydrous plutonium, americium, and lanthanum trichlorides were measured in solutions of ethylenediaminetetraacetic acid at a carefully chosen pH, and in inorganic solutions of the same ionic strength. From these data the enthalpy change for the reaction was calculated to be: $MeCl_{3(c)} + 2HY^{3-}_{(aq)} \rightarrow MeY^{-}_{(aq)} + H_2Y^{2-}_{(aq)} + 3Cl^{-}_{(aq)}$. Using auxiliary data the thermodynamic quantities $\Delta H°$, $\Delta F°$, and $\Delta S°$ associated with the chelation are reported for 25°C and $\mu = 0.1$ and the results with actinide chelates were compared with literature values for the corresponding lanthanides. (auth)

24515 POLAROGRAPHY OF LANTHANUM IN TETRAMETHYLAMMONIUM CHLORIDE MEDIA. M. L. Mittal and R. S. Saxena (Government Coll., Kota, Raj, India and Malaviya Regional Engineering Coll., Jaipur, India). J. Less-Common Metals, 8: 347-51(May 1965).

The polarographic behavior of La^{3+} at a dropping mercury electrode was investigated in the presence of 0.2 M tetramethylammonium chloride and 0.001% gelatin. At a temperature of 28 ± 0.05°C and pH range 4.8–6.0, a reversible wave having a half-wave potential of about –1.34 V(vs. S.C.E.) with probable reaction mechanism $La^{3+} + e = La^{2+}$ and n = 1 was obtained. The effects of change of temperature, height of the Hg column, concentration, and pH were studied. The values of temperature coefficients of i_d at different temperature levels, which were found to increase

with increasing temperature (0.974% per degree at 28.5°C and 1.81% per degree at 51.0°C), and non-linearity of wave height with La^{3+} concentration indicate that the wave produced by La^{3+} is not diffusion-controlled; it is neither very reproducible nor well-defined. (auth)

24516 FIELD GRADIENT IN BeO. H. C. Bolton and C. A. Sholl (Monash Univ., Clayton, Victoria, Australia). J. Nucl. Mater., 14: 265-71(1964).

The field gradient in BeO was calculated on the basis of an ionic model with the lattice sums evaluated by the method of de Wette. It was found impossible to obtain agreement with the experimental value, even when dipolar and quadrupolar terms are included in the expansions. However, agreement was obtained for lattice parameters slightly different from the experimental values. It is thus uncertain if BeO can be represented by an ionic model. (auth)

24517 GROUND STATE OF ZIRCONIUM MONOXIDE FROM NEON MATRIX INVESTIGATIONS AT 4°K. William Weltner, Jr. and Donald McLeon, Jr. (Union Carbide Research Inst., Tarrytown, New York). Nature, 206: 87-8 (Apr. 3, 1965).

On the basis of absorption studies of the ZrO molecule in neon matrices at 4°K, it was concluded that ZrO has a singlet, $^1\Sigma^+$ ground state. (D.C.W.)

24518 INVESTIGATION OF OPTICAL ACTIVITY PRODUCED IN THE CRYSTALLINE STATE. II. SODIUM-URANYL-ACETATE. V. A. Kizel', Yu. I. Krasilov, and V. N. Shamraev. Opt. i Spektroskopiya, 18: 123-9(1965).

The dispersion of the optical activity of sodium uranyl acetate and its circular dichroism were measured simultaneously with some investigations of its absorption spectrum. The technique of measuring the dispersion of the optical activity and the construction of the cryostats employed were described previously (Opt. i Spektroskopiya, 17: 863, (1964)). The setup for measuring circular dichroism is illustrated. Some new bands were observed and the dichroic bands were found to be asymmetrical. The dichroic bands shifted and deformed with variation of the temperature. A detailed study of the behavior of the 4,732 Å band with variation of temperature showed that the maximum wavelength and the half width of the band vary linearly with temperature for temperatures above 120 to 130°K. At lower temperatures the variation is very weak. The dispersion of the optical activity was investigated in greatest detail for the 4,732 Å band. The dispersion curve was asymmetrical and was also noticeably shifted and deformed with variation of temperature. The measurements showed that an appreciable circular dichroism is retained for the 4,732 Å band even at room temperature. An appreciable increase in the dichroism began below 130 to 150°K. (CFSTI).

24519 OPTICAL ACTIVITY IN THE CRYSTALLINE STATE. II. SODIUM URANYL ACETATE. V. A. Kizel, Yu. I. Krasilov, and V. N. Shamraev. Opt. Spectry. (USSR) (English Transl.), 18: 62-5(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 123-9(Jan. 1965).

The dispersion of optical activity and circular dichroism were measured for certain bands of sodium uranyl acetate; spectral parameters were measured as a function of temperature. It is shown that the absorption bands and the dispersion curves are asymmetrical, and that they change their shapes and positions considerably with changing temperature. (auth)

24520 THE ADSORPTION OF COPPER ON TUNGSTEN. J. P. Jones (National Chemical Lab., Teddington, Middx, Eng.). Proc. Roy. Soc. (London), Ser. A, 284: 469-87(Mar. 23, 1965).

A detailed examination was made by field emission microscopy, of the behavior of small amounts of copper evaporated onto a clean tungsten point in an ultrahigh vacuum. With increasing thickness, the behavior of the copper deposit and its effect on work function change in a way which leads to classification of three types of copper layer. Small amounts of copper form a layer on the surface which raises the work function from 4.52 to 4.83 ev and can be desorbed thermally with activation energy 95 ± 6 kcal/mole. It is termed type I, and is believed to form the first monolayer of copper in which all adatoms are bonded directly to tungsten and are therefore polarized negative outward, giving rise to the observed increase in work function. Copper adsorbed upon the type-I layer forms type II, which lowers the work function to 4.2 ev, diffuses over the tip surface with activation energy 20 kcal/mole, and is desorbed thermally with activation energy 70 ± 7 kcal/mole. It is believed to comprise a layer two atoms thick which forms a copper lattice strained to conform to the substrate structure. Copper adsorbed upon the type-II layer is of type III. It is less strongly bound than type II, being desorbed with activation energy 64 ± 3 kcal/mole and diffusing over the tip surface with activation energy 12 kcal/mole. The increase in measured work function from 4.2 to 4.8 ev produced by type III is thought to be due to a change in the shape of the tip surface. It is stable up to a thickness of about three atom layers, and addition of further copper produces nuclei which are thought to be crystallites having a true copper lattice structure. The observations reported are believed to be consistent with a description of epitaxial overgrowth given by van der Merwe, and thus contrast with much other work on epitaxial overgrowth of pairs of metals with differing lattice dimensions. (auth)

24521 ENTHALPY OF THE AMORPHOUS URANIUM TRIOXIDE REACTION WITH SULFURIC ACID. L. M. Vidavskii, V. Yu. Koval'chuk, N. I. Byakhova, and E. A. Ippolitova. Vestn. Mosk. Univ., Ser. II, Khim., No. 5, 65-8(Sept.-Oct. 1964). (In Russian)

The enthalpy of the reaction of UO_3 with sulfuric acid was measured in order to determine the reproducibility of calorimetric data obtained with different UO_3 preparations. In one preparation, which was roentgenographically amorphous, $\Delta H_1 = -23.29 \pm 0.10$ kcal/g-atom of uranium. The error includes the error of reproducibility of the experiment, the average error in determination of the thermal values for the system (0.025 cal/day), and the reproducibility of the analytical determination of uranium (0.03%). A second preparation contained crystalline α-UO_3 as impurity. The enthalpy of crystallization of amorphous UO_3 is known to be -2.5 ± 0.3 kcal, and the correction for 27.5% α-UO_3 is -0.69 kcal. Then for this preparation $\Delta H_1 = -23.16 \pm 0.11$ kcal/g-atom of uranium. The error in this value includes, besides those mentioned, a 3% error in phase analysis and 0.3 kcal/mole in the crystallization enthalpy. Water in the preparations was not corrected for because the hydrate form and the enthalpy of dehydration are not known. However, the amount of water is so small that this error is considered negligible. The average enthalpy value is considered to be -23.23 ± 0.074 kcal/mole. Therefore the reproducibility of calorimetric measurements with amorphous UO_3 is 0.35%. (TTT)

24522 ON THE FRACTIONATION OF HYDROGEN ISOTOPES BETWEEN WATER AND THE HYDRATED HYDROGEN ION. Karl Heinzinger (Max-Planck-Institut fur Chemie, Mainz). Z. Naturforsch., 20a: 269-71(Feb. 1965). (In German)

New values for the degree of dissociation of perchloric acid, completely dissociated up to 8 moles/liter, lead to a change of the previously reported value of $\varkappa_L$ which is the equilibrium constant for the exchange reaction $H_2O + D^+(H_2O)_n = HDO + H^+(H_2O)_n$. Instead of $n = 1$ and $\varkappa_L = 0.96 \pm 0.02$ for all acid concentrations as reported, these values are valid only for low concentrations. For the highest concentration used in the measurement (7.125 moles/liter), one finds $n = 3/4$ and $\varkappa_L = 1.14$. (auth)

24523 ENHANCEMENT OF THE FLUORESCENCE OF CHELATES OF RARE EARTHS BY ADDITION COORDINATION. E. Butter and K. Kreher (Universität, Leipzig). Z. Naturforsch., 20a: 408-12(Mar. 1965). (In German)

It is shown that the fluorescence of various Eu-chelates (dibenzoylmethide, benzoylacetonate, acetylacetonate, and β-naphthoylacetonate) is much enhanced by addition coordination of phenanthroline or α,α'-dipyridil. Complexes of

the composition Eu(β-diketone)$_3$-phenanthraline, Eu(β-diketone)$_3$-dipyridil etc. could be isolated and the absorption and the fluorescence in various solvents were studied. Compared to the tris-chelates the temperature dependence of the additional coordinated chelates was remarkably reduced. (auth)

24524 SOME ORGANOPOLONIUM COMPOUNDS. V. D. Nefedov, V. E. Zhuravlev, and M. A. Toropova (Leningrad State Univ.). Zh. Obshch. Khim., 34: 3719-23 (1964).

Certain phenyl derivatives of polonium were prepared by a method developed for the corresponding compounds of tellurium. Tellurium-polonium tetrachloride, $Te(Po)Cl_4$, was used as the starting material for the synthesis of all the compounds. The organic derivatives of polonium were identified by means of partition paper chromatography from the α activity of ^{210}Po and the β and γ activity of ^{127}Te, the isotope with which tellurium was labeled. The yields of organic compounds of polonium and tellurium were determined by comparing the activities of these elements in the initial and final compounds. Tellurium polonium triphenyl chloride, $Te(Po)(C_6H_5)_2Cl$, was prepared by means of a Grignard reagent reacted with $Te(Po)Cl_4$. R_f values for $Te(Po)(C_6H_5)_2X$ type compounds were determined for the developing systems used in chromatographic identification. Diphenylpolonium and polonium diphenyl dichloride were also prepared by means of a Grignard reagent. The chlorination of diphenyltellurium-polonium is described. R_f values are also given for $PoOCl_2$, $PoCl_4$, $Te(Po)(C_6H_5)_2$, $Te(C_6H_5)_2Cl_2$, and $Po(C_6H_5)_2Cl_2$. The interaction of diphenyltellurium-polonium with tellurium diphenyl dichloride is described. (CFSTI)

24525 SPECTROSCOPY AND PHOTOCHEMISTRY OF URANYL COMPOUNDS. Eugene Rabinowitch and R. Linn Belford. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. Division XII. Chemistry. Volume 1. New York, The Macmillan Company, 1964. 377p.

Research on the interaction of uranyl ions with light is reviewed and a bibliography of over 300 references is included. Topics covered include: spectroscopy of uranyl salts in the solid state, spectroscopy of uranyl compounds in solution, uranyl fluorescence intensity and decay, photochemistry of uranyl compounds, and theory of uranyl ion structure and spectra. Presentation under each topic is largely chronological. (M.C.G.)

24526 FORMULA INDEX TO NMR LITERATURE DATA. VOLUME 1: REFERENCES PRIOR TO 1961. M. Gertrude Howell, Andrew S. Kende, and John S. Webb, eds. New York, Plenum Press, 1965. 215p.

Formulas for organic compounds whose proton magnetic resonance spectra were published in the literature up to 1961 are given. Over 2500 compounds are identified by empirical as well as structural formula (where known) or by trivial name. Compounds are arranged in order of empirical formula and fully referenced. (M.C.G.)

24527 ISOTOPIC EXCHANGE REACTIONS BETWEEN THIONYL CHLORIDE AND SULFURYL CHLORIDE. Ralph Lee Bain. Thesis, Corvallis, Ore., Oregon State Univ., 1964. 192p.

The rates of chlorine-36 and sulfur-35 exchange between thionyl chloride and sulfuryl in the pure solvents were investigated. For the chlorine-36 exchange reaction, law, $Rate = k_1(SOCl_2)(SO_2Cl_2) + k_2(SOCl_2)^2(SO_2Cl_2)^2 + k_3(SOCl_2)^3 SO_2Cl_2)^2$, gives a moderately good fit to the observed rate of exchange. The rate constants are found to be $k_1 = 1.51 \times 10^{-6}$, $k_2 = 1.80 \times 10^{-7}$, and $k_3 = 8.41 \times 10^{-8}$ liters^4 g-atom^{-4} day^{-1}. The Arrhenius energy of activation in an equimolar mixture of the reactants is found to be 7.23 kcal/mole for the chlorine-36 exchange reaction. The exchange of sulfur-35 between thionyl chloride and sulfuryl chloride is found to follow the law, $Rate = k_1(SOCl_2)(SO_2Cl_2)$, where k_1 is found to be 1.01×10^{-6} liters gram-atom^{-1} day^{-1}. The Arrhenius energy of activation is found to be 3.8 kcal/mole in excess thionyl chloride and 5.3 kcal/mole in excess sulfuryl chloride. The exchange reactions are interpreted in terms of a molecular mechanism. It is concluded that ionic dissociation processes in these media must be of quite minor significance. Chloride ion exhibits a strong catalytic effect on the rates of exchange of chlorine-36 and sulfur-35 between thionyl chloride and sulfuryl chloride. Antimony pentachloride is found to exchange chlorine-36 rapidly and completely with thionyl chloride but at best only slowly with sulfuryl chloride. Antimony pentachloride exhibits a weak catalytic effect on the chlorine-36 exchange reaction between thionyl chloride and sulfuryl chloride. There appears to be no catalysis by antimony pentachloride for the analogous sulfur-35 exchange reaction. Triethylamine catalyzes the exchange of chlorine-36 and sulfur-35 between thionyl chloride and sulfuryl chloride. Sulfur dioxide exhibits no catalytic effect on the exchange of chlorine-36 between thionyl chloride and sulfuryl chloride. (A.G.W.)

24528 ELECTRICAL CONDUCTANCE AND DENSITY FOR MOLTEN ALKALI METAL (Li, Na, K) MOLYBDATES AND TUNGSTATES. Press Lee Robinson. Thesis, Washington, D. C., Howard Univ., 1964. 118p.

Electrical conductance and density were determined for the five fused molybdate and tungstate systems: $K_2MoO_4-MoO_3$; $Li_2MoO_4-MoO_3$; $K_2WO_4-WO_3$; $Na_2WO_4-WO_3$; and $Li_2WO_4-WO_3$. Melts in these systems are envisioned as having a quasicrystalline structure on a short range basis. When conductances are compared at a "corresponding temperature" that is a fixed number of degrees above the melting-point, resemblance is observed between the conductance-composition diagrams and the phase diagrams of two systems, namely, $K_2MoO_4-MoO_3$ and $K_2WO_4-WO_3$. A model is suggested that accounts for the variation of conductance with temperature. This model is based on the postulates that the conduction process is ionic migration by diffusion that the principal current-carrying species are positive and negative ions derived from the thermal dissociation of the pure salts according to the scheme $A_2^{+1}B^{-2} \rightarrow A^{+1} + [A^{+1}B^{-2}]^{-1}$. The ion $[A^{+1}B^{-2}]^{-1}$ is defined as a contact ion and is believed to also play an important role in the conduction in these systems. Conductances of both pure salts and mixtures increase with temperature. Equivalent conductance plots, at corresponding temperatures, show negative deviations from additivity in at least one system, $Li_2MoO_4-MoO_3$, and positive deviations in the other four systems. A description of the apparatus, the calibration procedures, and the methods for measurement of electrical conductance and density are given in detail. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24529 MECHANISM OF THE PYROLYSIS OF DECABORANE. Charles Sung-Uk Park. Thesis, Newark, Del., Univ. of Delaware, 1964. 77p.

The vapor phase pyrolysis of decaborane in the temperature range of 180-412°C was studied by means of mass spectrometry. Several pyrolysis systems were used, including one where the reactor was connected directly to the heated inlet of the mass spectrometer and others where the products were trapped out for later analysis. When decaborane was pyrolysed in the reactor connected to the inlet of the mass spectrometer maintained at 100°C the mass spectra showed the formation of an icosaborane of a probable formula $B_{20}H_{26}$ in the pyrolysis temperature range of 275-355°C. However, when a similar reactor was connected to the inlet of a time-of-flight mass spectrometer maintained at room temperature, only the decaborane patterns appeared in the mass spectrum. The pyrolysis of the bridge-deuterated decaborane at 180°C yielded H_2, HD, and D_2 in the ratio of 25 : 12 : 1. Attempts to stabilize possible intermediates of the pyrolysis with air, oxygen, nitric oxide, ethanol, and propylene were carried out. A degradation study of the polymeric product of the decaborane pyrolysis was carried out with both ethanol and water. Evidence indicates that an icosaborane of a probable formula $B_{20}H_{26}$ is at least one of the more stable intermediates formed in the pyrolysis of decaborane, and that the polymeric product of the pyrolysis does not contain the structure of decaborane or any lower boranes. The probable position of the initial activation of the B-H bond is at the No. 5 position, according to the H_2, HD, and D_2 ratio obtained from the pyrolysis

of bridge-deuterated decaborane. Following the initial rate-determining step, the mechanism of the vapor phase pyrolysis of decaborane probably involves two reactions, one yielding the icosaborane which may pyrolyze further, and the other leading to the polymeric material, possibly through the fragmentation of $B_{10}H_{12}$. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24530 A STUDY OF THE DECOMPOSITION OF AMMONIA ON RARE EARTH OXIDES AND ON MnO–MgO SOLID SOLUTIONS. Thesis, Evanston, Ill., Northwestern Univ., 1964. 107p.

Evidence has accumulated in recent years to indicate that the electrical conductivity of an oxide semiconductor affects its catalytic properties. The rare earth oxides form a nearly ideal system for studying this because properties such as crystal structure, cation basicity, and cation radius of the various members are similar. Also, the exchange interaction between neighboring cations is slight and is not altered by impurities or defects. The conductivity of Eu_2O_3 in hydrogen at 800°C is greater than that of its neighbor, Gd_2O_3, by a factor of 20.5. The rate of the decomposition of ammonia at 800°C in mixture with hydrogen is the same on both of these oxides. These results indicate that the mere change of conductivity does not affect the catalytic activity for this reaction. The solid solutions of MnO-MgO form a second favorable system for isolating the effect of exchange interaction on catalytic activity. Both of these oxides have the same crystal structure and form homogeneous solid solutions, but because both contain dipositive cations the conductivity does not change appreciably with solution. The exchange interaction of manganous ions, however, is disrupted when the diamagnetic magnesium ions take their place in the lattice. The samples used as catalysts contained from 0-50% MgO in MnO. The rate of decomposition of ammonia at 690°C was the same on all of these catalysts. Thus, the alteration of exchange interaction by a diamagnetic impurity without a change in conductivity is also not sufficient to produce a change in catalytic activity for this reaction. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24531 ELECTRON DIFFRACTION STUDIES OF MOLECULAR STRUCTURE: CIS- AND TRANS-DIFLUORODIAZINE DIFLUOROAMINO RADICAL AND TETRAFLUOROHYDRAZINE, XENON TETRAFLUORIDE AND XENON HEXAFLUORIDE. Robert Karl Bohn. Thesis, Ithaca, N. Y., Cornell Univ., 1964. 118p.

Electron diffraction photographs of gaseous samples of the two isomers of difluorodiazine, the difluoroamino radical, tetrafluorohydrazine, xenon tetrafluoride, and xenon hexafluoride were taken with a rotating sector apparatus. The diffraction intensities were reduced quantitatively, and the structures were deduced from both radical distribution analyses and quantitative comparisons of theoretical with experimental intensities. The structure of the less reactive isomer of difluorodiazine is a trans configuration. The reactive isomer of difluorodiazine was confirmed to have a cis configuration. There is a small difference between the N-F bond lengths as determined by electron diffraction, 1.409 ± 0.013 A, and from microwave spectra, 1.384 ± 0.010 A. The structural parameters for trans- and cis-N_2F_2 are listed. The major structural difference between the two isomers is in the ∠NNF. The structure of tetrafluorohydrazine was found to be like that of hydrazine. Structural parameters for NF_2 and N_2F_4 are listed. The major structural difference between the two compounds is the larger N-F bond length in tetrafluorohydrazine. It appears that the odd electron in the radical contributes π-bonding character to the N-F bond. The structure of xenon tetrafluoride is a square planar configuration. Preliminary data were obtained on the structure of xenon hexafluoride. The results indicate that the structure has less than octahedral symmetry. The structural parameters for xenon tetrafluoride and xenon hexafluoride are listed. A survey of theories of bonding in the rare gas compounds is presented. A method of analysis of electron diffraction photographs for the determination of molecular structures is described in detail. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24532 SYNTHESIS OF NITROGEN FLUORIDES IN A NITROGEN PLASMA JET. B. R. Bronfin and R. N. Hazlett (Naval Research Lab., Washington, D. C.). 28p. (CONF-641201-17).

From American Institute of Chemical Engineers Annual Meeting, Boston.

The gases CF_4 and SF_6 were added to high-temperature nitrogen plasma jets. Upon quenching of the resultant mixtures, fluorine compounds were obtained, notably NF_3, N_2F_4, and CF_3NF_2. The composition of the mixture was investigated, together with the effect of input power to the arc and of the C : N : F ratio in the plasma on the yields. (D.C.W.)

24533 IMPROVEMENTS IN OR RELATING TO SOLID-GAS REACTIONS. Paul Vertes, Henri Huet, and Maurice Delange (to Commissariat a l'Energie Atomique). British Patent 966,898. Aug. 19, 1964. Priority date Nov. 28, 1960, France.

An apparatus for effecting a sequence of solid-gas reactions, particularly for the production of UO_2 by the reduction of UO_3, is composed of two assemblies. The first assembly comprises a tubular furnace and a tubular cooler. The furnace is provided with means for introducing at the first end and for circulating the solid phase, means for circulating gas countercurrent to the solid phase, and electrical heating means. A cooler provided with a water-filled double envelope with means for circulating the solid phase is connected to the second end of the tubular furnace. The second assembly is arranged to receive the solid phase from the first cooler and is made up of a vertical tubular furnace of the moving bed type, a horizontal tubular furnace, and a horizontal tubular cooler. At all stages of the second assembly a continuous screw means is provided for circulating the solid phase, and means is provided for circulating the gas countercurrent to the solid phase. Several variations of the basic apparatus are described, and the procedure for operation with specific reference to the production of UO_2 is described. (B.L.M.)

24534 IMPROVEMENTS IN OR RELATING TO METAL OXIDE SOLS AND SILICA SOLS. (to Diamond Alkali Co.). British Patent 968,202. Aug. 26, 1964. Priority date Apr. 4, 1960, United States.

A method is described for the production of aqueous sols of oxides of Si or of polyvalent metals including Cr, Ni, Fe, Al, Ba, Ca, Cu, Mg, Th, and U by liquid-liquid ion-exchange treatment of the aqueous solutions of salts of the metals. An aqueous solution of an inorganic salt (chloride or nitrate) of the metal or of an alkali metal silicate is mixed with a solution in a water-immiscible organic solvent of a water-insoluble organic compound. The organic compound is an alkyl amine when a metal sol is to be formed and an alkyl phosphoric, alkyl sulfuric, or alkyl carboxylic acid when a silica sol is to be formed. After the solutions have remained in contact for a sufficient period for the organic compound to remove the bulk of the anions of the metal salt or the alkali metal ions from the aqueous phase, the aqueous phase containing the desired sol is removed. The process is applicable to continuous operations if large amounts of the sols are to be produced. (B.L.M.)

24535 APPARATUS FOR THE CONTINUOUS PURIFICATION OF URANIUM HEXAFLUORIDE. Claude Fabre and Jean-Claude Martin (to Commissariat a l'Energie Atomique). U. S. Patent 3,160,490. Dec. 8, 1964. Priority date Aug. 14, 1959, France.

An apparatus for the purification of a gaseous sublimable material, particularly UF_6, consists of a turbine for cooling and expanding an impure gas current of UF_6 in order to cause the formation of crystals and a sublimating cyclone separation device for the simultaneous separation of the UF_6 by centrifugation and sublimation. The sublimating cyclone is constituted by a conical frustrum, the large end of which carries a tangential inlet for the gaseous fluid, and the small end of which constitutes the outlet for the gaseous fluid containing impurities. This conical frustrum has surfaces in the ratio of the amounts of gaseous fluid entering and leaving, lateral walls comprising a double

envelope where a hot fluid circulates partially to provide heat for sublimation of the crystals, and at least one pipe located at the apex for the outlet of pure UF_6. The gas from which the crystals of UF_6 have been separated and containing a non-crystallized part of the UF_6 is recompressed and recooled to be recycled to the initial gaseous current. A fraction of recycled gas is continuously eliminated to remove impurities. The process is continual and is particularly economical, because the power necessary is furnished to a large extent by the gaseous fluid itself. (B.L.M.)

24536 PROCESS FOR RECOVERING THE CATALYST IN AN INSTALLATION FOR THE ENRICHMENT OF A HYDROGENATED COMPOUND IN DEUTERIUM. Grégoire Dirian and Henri Sack (to Houilleres du Bassin du Nord and Commissariat a l'Energie Atomique). U. S. Patent 3,163,589. Dec. 29, 1964. Priority date Aug. 6, 1959, France.

A process is patented for recovering the alkali metal amide catalyst used in enrichment of ammonia in deuterium by isotopic exchange. The alkali metal is transferred from the amide catalyst into an amalgam by electrolysis on a Hg cathode. The amalgam is used as the anode in a second electrolytic cell containing ammonia of low deuterium content as the solvent electrolyte. The alkali metal amide of low deuterium content thus formed is returned to the enrichment cycle. (A.G.W.)

24537 RARE EARTH ACTIVATED ALKALINE EARTH HALOFLUORIDE LUMINESCENT MATERIALS. Perry N. Yocom (to Radio Corp. of America). U. S. Patent 3,163,610. Dec. 29, 1964. Filed Mar. 26, 1962.

Luminescent materials particularly useful as laser materials are described. In general the luminescent materials have a tetragonal crystal structure and the molar composition AHaF : yM where: A is at least one of Ba, Ca, and Sr; Ha is at least one of Cl, Br, and I; F is fluorine; M is at least one of Sm^{+2}, Tm^{+2}, and U^{+3}; and y is between about 10^{-6} and 10^{-1} mol. They are prepared by fusing pure anhydrous constituent halides in atmospheres conducive to developing the desired valency in the dopant and solidifying the melt by cooling to room temperature in the atmosphere. When excited with suitable radiation energy, the materials luminesce, emitting radiation in relatively narrow bands whose wavelength is related to the dopant. When prepared in single-crystal form, at least some of the crystals can be made to lase. (A.G.W.)

24538 PROCESS OF MAKING ACTINIDE SULFIDE AND SIMILAR COMPOUNDS. Yehuda Baskin (to U. S. Atomic Energy Commission). U. S. Patent 3,180,704. Apr. 27, 1965.

A process was developed for preparing an equiatomic phosphide, arsenide, sulfide, selenide, telluride, antimonide, or bismuthide of an actinide by mixing about stoichiometric amounts of the actinide and nonmetal powders; and applying a mechanical load of 4,000 to 10,000 psi and a temperature of 340 to 440°C. By this method an equiatomic compound is instantaneously and exothermically formed. (AEC)

Organic Chemistry

24539 (AERE-M-1387) THE PREPARATION OF 1,2-DI-n-BUTOXY ETHANE (DIBUTYL CELLOSOLVE). A. Pilbeam (Atomic Energy Research Establishment, Harwell (England)). Dec. 1964. 15p. Dep.; $0.50(BIS), 2s. 6d. (HMSO)

The development of the preparation of the liter scale of 1,2-di-n-butoxyethane (dibutyl cellosolve, DBC) based on the Williamson synthesis is described. The product is of suitable purity for use as a diluent in liquid/liquid extraction experiments related to the reprocessing of nuclear fuels. The analytical control of the specification of product by gas chromatography is described. Distribution of DBC in systems with mono-n-butyl cellosolve and water (or dilute nitric acid) have been measured and the solubility of purified DBC in water or dilute nitric acid obtained by infrared spectrometry. (auth)

24540 (EUR-2272.n) DE OZONOLYSE VAN DIFENYL EN DE DRIE ISOMEREN VAN TERFENYL. (The Ozonolysis of Diphenyl and the Three Terphenyl Isomers). G. de Vries (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Centraal Laboratorium). 1965. 10p. Dep.(mn).

A method which yields reproducible results has been developed for ozonization. The speed of the reaction of ozone with the three terphenyl isomers in chloroform and methylene chloride is fixed at −20°C. The difference in reaction speed between the isomers is too small to be used as a basis for a method of analysis. In contrast with the result stated in the literature, the reaction of ozone with meta-terphenyl at −20°C, whether or not in the presence of ethanetetracarbonitrile, is a diminishing reaction. (auth)

24541 (EUR-2282.d) BESTIMMUNG DER WARMELEITFAHIGKEIT DER GESATTIGTEN DAMPFE VON BENZOL, DIPHENYL, o-, m- UND p-TERPHENYL. (Determination of Thermal Conductivity in Saturated Vapors of Benzene, Diphenyl, o-, m- and p-Terphenyl). F. W. Reiter and W. Link (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 28p. Dep.(mn).

In a stationary hot wire apparatus thermal conductivity of the saturated vapors of diphenyl, o-, m- and p-terphenyl was measured up to pressures of 2 or 3 atmospheres, that of saturated vaporous and liquid benzene up to near the critical point. The experimental error is estimated to be less than 2%. A plot in reduced units showed that thermal conductivity of saturated vapors of similar substances fulfils the law of corresponding states very well. (auth)

24542 (NP-14853) GLYCIDIC ESTERS AND/OR ORGANIC DISULFIDES, AND RELATED SUBSTANCES, AS SOURCES OF ANTI-RADIATION DRUGS. Interim Research Report No. 21, October 1, 1964−December 31, 1964. R. B. Barbee, J. D. Buckman, H. K. Kim, and W. B. Lacefield (Vanderbilt Univ., Nashville, Tenn.). Contract DA-49-193-MD-2030. 17p.

Six compounds were submitted for screening as possible radioprotective compounds. Oxidation of 1,2-dithiocyclohexane has given compounds which may be the cyclic thiolsulfonate and the α-disulfone; the latter was apparently identical with an oxidation product of 1,4-butanedisulfinic acid, this seemingly confirming its structure. Unsymmetrical disulfides were prepared of the structure CH_3-NHC(S)SSR. The fact that R could be an aryl, t-alkyl, or primary alkyl group shows that these compounds can be prepared with wide structural variations in R. An aryl disulfide of the structure ArC(O)SSR was prepared by thioalkylation of a thio acid with a thiolsulfonate. Compounds can now be sought in which R is an aminoethyl moiety. Sulfuryl chloride was substituted for chlorine in the preparation of a thiolsulfonate from a thiol; since sulfuryl chloride is easier to handle, the development is a promising one. A highly promising new synthesis of trisulfides (RSSSR) was developed. It involves thioalkylation of potassium sulfide or hydrosulfide with a thiolsulfonate and can be used where R is either aryl or primary alkyl. Disproportionation studies of 2-aminoethyl 2,6-dimethoxyphenyl disulfide hydrochloride show it to be thermally quite unstable. Selective oxidation of o-substituted aryl 2-aminoethyl disulfide hydrochlorides seems unpromising as a means of preparing unsymmetrical thiolsulfonates. o-(2-Aminophenyldithio)benzoic acid was prepared as an analog of an active agent submitted previously. Research on mercaptodisulfides was continued. 2-Naphthyl and phenyl dithiosulfite were prepared. The stability of t-butyl 2-acetamidoethyl dithiosulfite seems to be too low to make it a promising compound for screening. (auth)

24543 ON SOME FACTORS AFFECTING THE ISOTOPIC EXCHANGE OF IODINE ATOMS. E. Koeroes, L. Pataki, L. Ladanyi, M. Orban, and V. Keresztes-Hamar (L. Eotvos Univ., Budapest). Acta Chim. Acad. Sci. Hung., 41: 171-86(1964).

Previously it was shown that the rate of isotopic exchange of iodine (^{131}I) atoms between I_2 and 4-iodoanti-

pyrine (I-ap) varied in different solvents. The half-time of the exchange ($t_{½}$) at 20°C and at a $[I_2] = [I\text{-ap}] = 7 \times 10^{-3}$ M was found to be between 5 and 200 min, except in nitrobenzene where the exchange was instantaneous and in pyridine with a $t_{½} \cong 33$ hr. To study the exchange reaction more thoroughly the role of the nitro group and that of the azine nitrogen was studied, as well as the temperature-dependence of the exchange reaction. Aliphatic alcohols ($C_1 - C_4$) were used as polar solvents and benzene and chloroform as nonpolar ones. The exchange process was shown to follow an exponential law; in each solvents similar curves were obtained. The temperature-independence of the rate constant in benzene, chloroform, and in a benzene-nitrobenzene solution indicated that the exchange reaction does not require activation energy in these solvents, but such energy is required with polar solvents. These results indicated that the exchange reaction needs activation energy in those solvents, where a considerable interaction occurs between the solvent and the iodine molecule. The presence of nitro compounds (both aromatic and aliphatic) accelerates the exchange reaction. Log $t_{½}$ (the half-time of the exchange) plotted against the concentration of the nitro compounds gave straight lines. The accelerating effect of the nitro compound also depended on the solvent. A new term, the accelerating coefficient (ϑ), was introduced, to distinguish between the accelerating power of the nitro compounds. The azine nitrogen retarded the exchange reaction due to a strong interaction with I_2. When $t_{½}$ is plotted against the concentration of the azines, straight lines resulted. The degree of retardation can be expressed by the retardation coefficient, δ. Some azines in very low concentration showed an accelerating effect, where the exponential relation between $t_{½}$ and the concentration was valid. The accelerating effect observed for azine compounds such as collidine and acridine can be explained by assuming that these compounds only polarize the I_2 molecule at a very low concentration. Higher concentrations of these compounds resulted in the dissociation of I_2, followed by the formation of a linkage between I^+ and azine nitrogen. The exponential decrease in $t_{½}$ presumably resulted from energetic factors; the linear increase in $t_{½}$ indicated a decrease in the number of favorable collisions. (BBB)

24544 SECONDARY α-DEUTERIUM KINETIC ISOTOPE EFFECTS IN SOLVOLYSES OF 2-CYCLOPENTYLETHYL, 2-(Δ^2-CYCLOPENTENYL) ETHYL, AND 2-(Δ^3-CYCLOPENTENYL) ETHYL p-NITROBENZENESULPHONATES. C. C. Lee and E. W. C. Wong (Univ. of Saskatchewan, Saskatoon). Tetrahedron, 21: 539-45(Mar. 1965).

Kinetics of solvolysis of 2-cyclopentylethyl, 2-(Δ^2-cyclopentenyl) ethyl, and 2(Δ^3-cyclopentenyl) ethyl p-nitrobenzenesulfonates (I, II, and III, respectively) and the corresponding 1,1-dideuterated analogs, I-d_2, II-d_2, and III-d_2, were studied in 25% water-75% dioxane and in glacial acetic acid at various temperatures. The very small k_H/k_D values observed for I and I-d_2 suggested considerable S_N2 character for the solvolysis of this system. Small but appreciable isotope effects were noted for II and II-d_2. Solvolyses of III and III-d_2 showed the highest isotope effects; k_H/k_D for acetolysis was about 1.14. This value was much less than an expected rate retardation of about 15% per α-D atom for acetolysis with a limiting or S_N1 mechanism. The results were interpreted as in agreement with Streitwieser's postulation that neighboring group participation in the rate-determining step will lower the magnitude of the α-D kinetic isotope effect. Consideration of the activation parameters suggested the probability that for the systems studied, differences in enthalpies rather than entropies of activation contribute more to the rate retardation after D substitution at the α-carbon. (BBB)

24545 MÖSSBAUER SPECTROSCOPY OF ORGANOTIN COMPOUNDS. R. H. Herber and H. A. Stoeckler (Rutgers Univ., New Brunswick, N. J.). Trans. N. Y. Acad. Sci., 26: 929-33(June 1964).

The Mössbauer parameters of 20 organotin compounds were investigated. The two parameters obtained from the Mössbauer spectrum were the isomer shift (IS) and quadrupole splitting (QS). The former arises from the fact that the nucleus has a finite radius, which is different for the ground state and excited state configuration, and as such interacts with the electron wave functions of the environment. It is experimentally observed as the displacement from zero relative velocity of the center of the Mössbauer spectrum. In the case of ^{119m}Sn spectra, an isomer shift of 1 mm-sec^{-1} corresponds to an energy of 7.85×10^{-8} ev or 1.85×10^{-3} cal-mole^{-1}. The QS arises from the twofold degeneracy of the excited nuclear state in ^{119m}Sn. This degeneracy can be removed when the resonant atom occupies a lattice point where the electric field gradient tensor is nonvanishing (i.e. in a noncubic configuration). Tin atoms in tetrahedral or octahedral symmetries are expected to show zero QS. All measurements are reported with reference to a ceramic source of $^{119m}SnO_2$ at room temperature. The experimental data were summarized in a table showing line width, IS, and QS for 18 compounds. These data showed that in addition to the expected absence of measurably large quadrupole splitting in $(C_6H_5)_4Sn$, $(neo)_4Sn$ [the symbol (neo) is used to identify the neophyl group, 2-phenyl-2-methylpropyl-1 radical], and $(C_6H_{11})_4Sn$, such splitting is also absent in the binuclear tin compounds and in the tris (p-fluorophenyl) tin hydride. The absence of quadrupole splitting in the former is consistent with the tetrahedral configuration of the bonding orbitals of tin. The absence of quadrupole splitting in the binuclear compounds implies the near identity of s-electron density in a tin bond compared to a tin-carbon bond. The data also showed that the change in the π-electron density in the phenyl ring arising from meta or para substitution of electronegative groups such as F– or CF_3– has little effect on the s character in the carbon-tin bond. The near similarity of the QS for $(neo)_3SnI$ and $(neo)_3SnN_3$ suggested that in the presence of large anions, the neophyl group provides too great a steric hindrance for pentacoordination around the tin atom. The largest QS was observed for $(neo)_3SnF$. The IS values fell on a smooth linear plot of IS vs the sum of the ligand electronegativities. This linear correlation could provide a useful diagnostic tool in the investigation of symmetry and bond character in organo-tin compounds. (BBB)

24546 POLYMERISATION PRODUCTS FOR USE AS PROTECTION AGAINST THE ACTION OF HEAT AND RADIATION. (to Farbenfabriken Bayer AG). British Patent 967,223. Aug. 19, 1964. Priority date Oct. 20, 1961, Germany).

A process is described for the preparation of a polymeric material for coating an object for protection against heat or radiation. The polymeric material is prepared by the homo- or co-polymerization of an inverted emulsion, i.e., the suspension of an aqueous phase in an oil phase containing the polymeric material. The preferred materials for polymerization are organic monomers containing at least one terminal $CH_2=C<$ group in the molecule and having a solubility in water not exceeding 10 wt %. The polymerized product may contain up to 3000 vol % of water. If a cross-linked polymer is desired, the monomers may be polymerized in the presence of 0.05 to 95 wt % of other monomers containing a plurality of olefinically unsaturated carbon to carbon double bonds. Before polymerization, the emulsion may be cast in the pourable state into prepared molds or may be poured or painted on to the surface of the body to be protected. If greater strength is desired, fillers may be incorporated into the emulsion or reinforcing members may be incorporated into the polymer. In order to enhance the protective action, heavy water, graphite, or heavy metal salts may be added to the emulsion. (B.L.M.)

Radiation Chemistry

See *also* BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstracts 24868 and 24882.

24547 (AAEC/TM-282) COMPETITION KINETIC EQUATIONS FOR RADIOLYTIC DECARBOXYLATION OF AQUEOUS BENZOATE SOLUTIONS. R. W. Matthews and D. F. Sangster (Australian Atomic Energy Commission Re-

search Establishment, Lucas Heights). Mar. 1965. 7p. Dep.(mn).

The decarboxylation of benzoate during the irradiation of a dilute aerated aqueous solution by ionizing radiation involves additional post-irradiation production of carbon dioxide during the period immediately following the removal of the solution from the radiation field. Various possible reactions are considered and equations derived for the relationship between product yield, yield of the attacking species, reaction rate constants, and the relative concentration of two solutes competing for a common attacking species. The system can be used to measure relative rate constants. (auth)

24548 (CONF-799-12) APPARATUS FOR PRECISE MEASUREMENT OF SCINTILLATOR DECAY TIMES. R. L. McGuire, E. C. Yates, D. G. Crandall, and C. R. Hatcher (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). [nd]. Contract AT(29-1)-1183. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

A digital system has been built for making precise measurements of scintillator decay times. Time intervals between the start of a gamma-induced scintillation and the detection of a single light photon are measured with a time-to-height converter and stored in a pulse height analyzer. The apparatus has a time resolution of less than 2 nanoseconds, a dynamic range greater than four decades, and is able to detect both prompt and slow decay components in plastic and liquid scintillators. For all fast scintillators studied, the decay of light intensity over the first decade is approximately exponential. Results of measurements made on several commercially available scintillators are presented, including NE 102, Pilot B, Pilot A, and MEL-150C. (auth)

24549 ACTIONS OF ADDITION INITIATED BY RADIATION. I ADDITION OF CARBON TETRACHLORIDE ON ALKENES. Guy Rabilloud (Centre d'Etudes Nucleaires, Grenoble, France). Bull. Soc. Chim. France, No. 2, 293-8 (Feb. 1965). (In French)

The irradiation of an ethylenic hydrocarbon, in solution in carbon tetrachloride, by ^{60}Co γ radiation led to the addition of the carbon tetrachloride on the double bond with a reaction speed that is a function of the structure of the alkene. (tr-auth)

24550 RADIATION AND CATALYSIS. C. B. Amphlett (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. Ind. (London), No. 6, 249-55(Feb. 6, 1965).

The effects of radiation on catalytic systems and simple model systems, which were well characterized in the absence of radiation, are discussed. Studies of the physical and chemical sorption of simple gaseous molecules on solids of known composition reveal the effect on these processes of damage sustained by the solid on irradiation. These studies include simple catalyzed reactions (ortho-para hydrogen conversion, H_2-D_2 exchange, and N_2O decomposition) where these are free from complex effects arising from absorption of the products of reaction. The fact that many reactions occur under the influence of radiation even in the absence of a catalyst causes difficulty, since there is no guarantee that a reaction in the presence of both catalyst and radiation will be the same as that with the catalyst alone. Difficulties also arise in attempting to study reactions with preirradiated catalysts, since changes induced in solids by ionizing radiation are frequently reversed by subsequent thermal annealing; this may take place at temperatures below those at which it is desired to study the catalytic reaction. Under these limitations, most investigations were confined to relatively simple systems far removed from industrial practice, and even here the results were not clear. Some results are presented, which suggest ways in which more information might be obtained about conventional catalytic reactions and about the way in which radiation influences them. By combining work on pre-irradiated solids, which can be characterized by a variety of physical techniques (chemisorption, esr, conductivity, etc.) with a study of specific catalytic reactions on the same materials, further insight would be gained into the processes involved. Parallel experiments with chemically doped materials would show whether inferences based on modern theories of radiation damage and catalytic behavior are correct. In this way, it might be possible to predict instances where irradiation would promote or assist catalytic reactions. (BBB)

24551 THE ELECTRON SPIN RESONANCE SPECTRUM OF GAMMA IRRADIATED SODIUM TETRATHIONATE. D. S. Mahadevappa and R. L. Eager (Univ. of Saskatchewan, Saskatoon). Current Sci. (India), 34: 147-8(Mar. 5, 1965).

Studies were made on the electron spin resonance (ESR) spectra of $Na_2S_4O_6 \cdot 2H_2O$ following irradiation using ^{60}Co gamma rays. The spectrum at room temperature consisted of a single absorption line with a low field structure and measured about 90 G. No hyperfine splitting was observed. The electron spin concentrations increased at first with an increase in absorbed dose, but became almost constant at higher doses. (M.C.G.)

24552 THE MECHANISM BEHIND THE FORMATION OF DIALKYLPEROXIDES ON THE RADIATION OXIDATION OF HYDROCARBONS. M. F. Romantsev, V. V. Saraeva, and N. A. Bakh (Moscow State Univ. and Inst. of Electrochemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 622-5(Nov. 21, 1964). (In Russian)

Pure dry isooctane (2,2,4-trimethylpentane) and n-heptane were subjected to ^{60}Co gamma and x irradiation at a dose rate of 2×10^{16} ev/ml sec in the presence of various amounts of $O_2 + N_2$. The hydroperoxides were determined polarographically by reduction on a dropping mercury cathode in a benzene–methanol solution containing 0.3 M LiCl. The total peroxide compounds were determined iodimetrically. Alcohols and carbonyl compounds were determined colorimetrically. At low dose rates only hydroperoxides are found by the reactions $\dot{R} + O_2 \rightarrow R\dot{O}_2$, and $R\dot{O}_2 + RH \rightarrow ROOH + \dot{R}$. The G yield (ROOH) = 1.07 ± 0.05 does not depend on the oxygen concentration from 0.8×10^{-3} to 1.6×10^{-2} M O_2. On increasing the initial concentrations of isooctyl hydroperoxide, it was noted that dialkylperoxide compounds and alcohol are formed according to the mechanisms: $\dot{R} + ROOH \rightarrow R\dot{O} + ROH$, and $2R\dot{O} \rightarrow ROOR$. The disappearance of one ROOH molecule leads to the formation of one ROH molecule and 0.5 molecule of ROOR. The experimental data are in agreement with this mechanism. When the concentration of ROOH molecules becomes comparable with the concentration of O_2 molecules, competition for $\dot{R}$ radicals takes place between the reactions $\dot{R} + O_2 \rightarrow R\dot{O}_2$ and $\dot{R} + ROOH \rightarrow R\dot{O} + ROH$. (TTT)

24553 ELECTRON CAPTURE BY ACCEPTOR ADDITIVES IN THE RADIOLYSIS OF POLYVINYLCHLORIDE. B. V. Kotov and L. Zhaloudkova. Dokl. Akad. Nauk SSSR, 159: 640-3(Nov. 21, 1964). (In Russian)

Polyvinylchloride (PVC) film samples containing 0.03 to 0.6 mole % of electron-acceptor additives such as benzoquinone, anthracene, and tetrachloro-m-benzoquinone (chloranil) were prepared by evaporating down a dichloroethane solution. The samples were irradiated in sealed ampoules at a vacuum of 10^{-4} mm Hg std at 77°K with a ^{60}Co gamma dose rate of 0.6 to 1.7×10^6 Rads/hr. Absorption spectra indicate the presence of anion radicals in the irradiated polymer containing an additive. An analysis of the electron paramagnetic resonance (EPR) spectrum also shows the formation of an anion radical. The radical yield does not depend on the temperature of irradiation from 77 to 133°K, but the radicals are not stable at room temperature. Saturation takes place at a dose of 12 to 15×10^6 Rads for the chloranil anion-radical. With anthracene and n-terphenyl, a maximum radical concentration occurs at 3 to 4×10^6 Rads with a slight decrease at higher doses. The accepter molecule captures a thermal electron during irradiation to form an anion radical. The yield of H_2 does not depend on the presence of the acceptor, and is ~0.2 molecules/100 ev at 77°K. The G yield of HCl is ~1.6 to 1.7. The evolution of HCl after the irradiation is inhibited by addition of an electron acceptor. (TTT)

24554 HETEROLYTIC FORMATION OF FREE RADICALS IN THE RADIOLYSIS OF ORGANIC SOLIDS. V. V.

Voevodskii. Dokl. Akad. Nauk SSSR, 159: 876-8(Dec. 1, 1964). (In Russian)

The rupture of a C-H bond is an important step in explaining the formation of radicals on the irradiation of saturated hydrocarbons (RH) and aromatic hydrocarbons (ArH). The experimental results are still in agreement with the Frank-Rabinovitch rule, which states that the formation of two heavy radicals by a direct fission process is highly improbable. Hence, in explaining the formation of R radicals during the radiolysis of RX compounds, a heterolytic break-down of an excited (RX)* particle can be assumed to be: $(RX)^* \rightarrow \dot{R} + \dot{X}^- + (+)_{loc.}$, or in the case of an electropositive X, $(RX)^* \rightarrow \dot{R} + X^+ + (e)_{loc.}$. EPR data indicate that a RĊHI radical is formed by this mechanism on irradiating a normal alkyl iodide at 77°K. This mechanism is also involved to explain the difference in results observed during the photodecomposition of CH_3OH at 77°K in acid and basic media. The nature of the primary radiolytic event depends strongly on how well the lattice can localize a plus or minus change. (TTT)

24555 INTERACTION OF γ-RADIATION WITH WOOD SUBSTANCES. S. Markus and J. Jokel. Drevar. Vyskum, No. 1, 7-18(1964). (In Czech)

An investigation was made of the linear absorption coefficient and its exact determination in wood substances. The exponential dependence of the attenuation of the γ intensity interacting with a wood substance is shown. From the theoretical analysis of individual physical phenomena, photoelectric effect, Compton effect, and pair production, the linear absorption coefficients for 7 various wood species dependent on the γ energy were calculated. The results indicated in which γ energy bands these physical phenomena were predominant. Equations are given for finding a suitable method for determining some physical values for wood and the geometry of an experiment. These equations permit a comparison to be made of the experimental values of linear as well as of the mass absorption coefficient with theoretical coefficients. (OID)

24556 THE EFFECT OF NUCLEAR RADIATION ON THE PROPERTIES OF FIBERS. III. FURTHER INVESTIGATIONS WITH REACTOR RADIATION. W. Bobeth, et al. Faserforsch. Textiltech., 15: 1-9(Jan. 1964). (In German)

Threads of various fibers, rolled on spools and placed in an Al container, were bombarded with different doses of neutrons in the atomic reactor at the Atomic Research Center, Rossendorf, near Dresden, in air and at temperatures between 60 and 90°C. In one series of experiments, slow neutrons at doses from 10^{13} to 10^{17}n/cm^2 from 56 sec to 43.7 hr, and fast neutrons at dose rates from 10^{13} to 10^{16}n/cm^2 from 295 sec to 47.7 min were used. The accompanying γ radiation ranged from 4.8×10^4 to 2.2×10^6r. Results of examinations by various textile industry test methods after irradiation indicated that: polyamide fiber (DEDERON Monofil) was remarkably resistant at low doses, but it weakened, increased in density and swelling, and decreased in strength at higher doses; polyacrylonitrile fiber (WILCRYLON) lost strength at lower doses and its swelling property increased; polyester fiber (TREVIRA silk) was the least affected by radiation of all of the fibers examined; Cuprammonium rayon ("Kupferseide") was extremely sensitive to radiation in every property investigated; and natural flax yarn was very sensitive and decomposed at relatively low doses. (OID)

24557 RADIATION POLYMERIZATION. Tin-wu Chang. Hua Hseuh Tung Pao, No. 10, 14-27(Oct. 14, 1963). (In Chinese)

The scientific and practical importance of radiation polymerization is discussed. The free radical and the ionic mechanism concepts and their technological implications are critically evaluated. Solid-phase polymerization by irradiation at low temperatures is considered. Gas-phase polymerization is examined and considered as proof of the ionic mechanism. It is pointed out that although that mechanism is real, the chemical mechanism involved is not sufficiently well understood. This is also true in the case of low-temperature solid-phase polymerization by irradiation, e.g., for formaldehyde irradiated at −196°C with the γ radiation from ^{60}Co source. The material explodes when heated to −78°C, raising the question of when polymerization actually takes place. It is suggested that x-ray analysis, electron magnetic resonance, and electron microscope techniques may be used to trace the path of the reaction, especially in the solid phase. (TTT)

24558 DISTRIBUTION OF THE LATENT IMAGE IN EMULSION GRAINS IRRADIATED WITH X-RAYS. I. Malinovski (Malinowski), M. Todorova, and M. Djambazova. Izv. Inst. Fizikokhim., Bulgar. Akad. Nauk, 2: 207-17 (1962). (In Bulgarian)

It was previously demonstrated that in the case of irradiation with x rays the average energy spent on a developed grain is of the same order for the various commercial photographic materials, increasing approximately proportionally to the cube root of the average mass of the emulsion grains. This correlation is explained by the formation of a dispersed latent image. The distribution of the latent image in the depth of the emulsion grains was studied so as to elucidate the physical meaning of the correlation observed. A technique was used for the distinct development of the surface and internal latent image. The densities of darkening obtained on the development of the surface and the first and second internal layers with a thickness of about 100 to 200 Å were measured. The concept of the concentration of the centers of development in the separate layers is introduced for characterizing the distribution of the latent image. Determination of this concentration requires a knowledge of the density of darkening for each layer (with a correction for the reduction in the area of grains during the appropriate treatment), as well as a knowledge of the volume of the layer in which the developer penetrates. The data showed that the concentration of the latent image in the surface layer is of another order in comparison with its concentration in the interior of the emulsion grains. This domination of the surface image, even in the case of exposure with x rays, could not be put in harmony with deviations from the photographic reciprocity law if the ratio between the energy expended on the formation of the latent image in the surface layer and that expended in the interior of the total volume of the emulsion grains was not taken into account. The data obtained about the topography of the latent image are approximate because of the shortcomings of the methods used, but they make it possible to make an estimation of the absolute value of the energy expended on the formation of a surface latent image alone. For all the materials studied this energy proved to be approximately the same, about 300 ev, the bulk of the total energy absorbed going for the formation of the internal undeveloped latent image. (auth)

24559 ELECTRON SPIN RESONANCES IN GAMMA-RAY IRRADIATED SODIUM CHLORATE. [PART] I. F. T. Gamble (Denison Univ., Granville, Ohio and Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys., 42: 3542-5(May 15, 1965).

Single crystals of $NaClO_3$ were subjected to gamma irradiation at room temperature. Analysis of the resulting electron spin resonance spectrum indicated the production of three paramagnetic centers, initially, each with an effective spin of ½. The measured parameters of a center having resolved hyperfine structure and identified as ClO_3 were $g_{||} = 2.0085 \pm 0.0010$, $g_{\perp} = 2.0090 \pm 0.0010$, $A = 14.8 \pm 0.1$ G, and $B = 21.2 \pm 0.1$ G. No hyperfine interaction was detected for the remaining two centers having $g_{||} = 2.007 \pm 0.001$ and $g_{\perp} = 2.020 \pm 0.001$, and $g \simeq 2.008$, respectively. The centers were reasonably stable at room temperature for several months. (auth)

24560 RADIATION-INDUCED POLYMERIZATION OF STYRENE IN A DRY SYSTEM. Katsuji Ueno, Koichiro Hayashi, and Seizo Okamura (Kyoto Univ.). J. Polymer Sci., Pt. B, 3: 363-8(May 1965).

Radioinduced polymerization of styrene was carried out in a dry system. A Na–K alloy was used as a drying agent and ^{60}Co as the radiation source. The rate of polymerization of the monomer dried by the Na–K alloy was enhanced

by a factor of 2 or 3. Scavengers were used to study the polymerization mechanism. The rate of copolymerization of styrene with α-methylstyrene in the extremely dry system was about a hundred times as large as that in an ordinary system. It was concluded that polymerization of styrene at room temperature in an extremely dry system takes place by a cationic mechanism. (M.C.G.)

24561 EFFECT OF IRRADIATION ON CHANGES IN THE PROPERTIES OF GREASE DISPERSION MEDIA. E. D. Makeeva, L. A. Kumleva, Yu. S. Zaslavskii, and N. E. Shchipina. Khim. I Tekhnol. Topliv i Masel, No. 9, 38-40(1964).

Changes in the properties of oils used as dispersion media (liquid lubricants) in greases under γ-irradiation were studied. In addition, the anti-irradiation effects of additives such as dialkyl selenide and acenaphthene were investigated. Irradiation was carried out at about 50°C using a Co source, with integral doses of 1×10^7, and 1×10^8 R. The effect of irradiation was evaluated by viscosity, evaporation and gelation-temperature measurements. The experiments were conducted with silicone oils, bis(2-ethylhexyl)silacate, and other diesters. The results of the study, given in tables, show that γ-irradiation at these doses increases the viscosity of the liquid lubricants listed and, in some instances, causes their gelation. Simultaneously, evolution of volatile products takes place. The radiation resistance of polyorganosiloxanes decreased with an increase in their molecular weight and depends on the organic substituents at the Si atom. The introduction of phenyl radicals in polyorganosiloxane molecules increased their radiation resistance. The radiation resistance of diesters was increased by the introduction of aromatic radicals. Acenaphthene was the best anti-irradiation additive for both polyorganosiloxanes and diesters. (CFSTI)

24562 RADIATION-INDUCED SOLID STATE COPOLYMERIZATION OF ACRYLIC AMIDE AND ACRYLIC ACID. Gyula Hardy and Lajos Nagy (Muanyagipari Kutato Intezet, Budapest). Magy. Kem. Folyoirat, 71: 91(Feb. 1965). (In Hungarian)

The solid system of acrylamide and acrylic acid has a phase-diagram with two eutectic points, and a molecular compound of 1:2 molar ratio is present which has the highest melting point. The rate of copolymerization is the greatest in the eutectic points, and goes through a minimum at the composition corresponding to the molecular compound. (auth)

24563 FORMATION OF PARAMAGNETIC SPECIES IN SODIUM NITRITE IRRADIATED AT ROOM TEMPERATURE. N. M. Atherton, R. N. Dixon, and G. H. Kirby (Univ. of Sheffield, Eng.). Nature, 206: 83-4(Apr. 3, 1965).

The production of NO_2 and $N_2O_4^-$ in the gamma radiolysis of sodium nitrite was investigated by obtaining ESR spectra at different irradiation times. It was found that NO_2 was produced at a constant rate up to about 300 hr, after which the rate slowed somewhat. The initial rate of $N_2O_4^-$ formation was quite high. The decay of the ESR spectrum under annealing was also followed. A mechanism for $N_2O_4^-$ production was proposed. (D.C.W.)

24564 RADIATION POLYMERIZATION OF ALLYL ALCOHOL AND CERTAIN OTHER ALLYL DERIVATIVES. S. A. Dolmatov and L. S. Polak. Neftekhimiya, 3: 683-9 (Sept.-Oct. 1963). (In Russian)

Allyl alcohol and 12 of its derivatives (mono- and dialkyl-, amino-, cyano-, Cl-, Br-, and S-substituted) were placed in sealed glass ampoules and irradiated with ^{60}Co γ rays from −196 to 300°C. The infrared spectra of the reaction mixtures before and after γ irradiation along with other experimental data showed that allyl alcohol and its derivatives polymerized under the action of γ rays to form the corresponding polymers (previously unreported) with molecular weights ranging from 10^4 to 10^5 depending on irradiation dose and temperature. The presence of O did not affect the rate of polymerization. At a constant temperature and radiation intensity, the polymer yield was directly proportional to the radiation dose. The polymerization can be carried out in bulk or in solution; e.g., the polymerization of allyl alcohol containing 28% water proceeded much faster than the corresponding bulk polymerization. Poly(allyl alcohol) was thermoplastic, heat resistant in air, and readily formed transparent films and fibers. In most cases the monomer conversion of energy absorbed was low (about 10 to 15 mol/100 ev); hence, the required high doses (about 10^9 R/g for a 50% conversion) indicated that either the polymerization was not a chain reaction or that the chains were very short. By discontinuing the irradiation the process may be stopped. Monomer radiolysis and polymer grafting were not observed. (OID)

24565 THE RELATIONSHIP BETWEEN THE SPECTRA AND MOLECULAR STRUCTURE OF LUMINORS USED IN SCINTILLATORS. R. N. Nurmukhametov and L. L. Nagornaya. Opt. Spectry. (USSR) (English Transl.), 18: 55-7(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 109-14(Jan. 1965).

A comparative analysis was carried out on the absorption and luminescence bands of the arylethylenes, aryloxazoles, and aryloxadiazoles. Measurements of the absorption spectra were made in heptane and of fluorescence spectra in heptane and polystyrene at 20°C. The shifts in the spectra with substitution in each compound series are discussed. To understand the identical character of the spectral changes when substituting one aryl for another in all three series, the electronic bands of the arylethylenes are considered in detail. The appearance of new bands is hypothesized as being due to excitation of the π electrons of the aryl rings. (D.L.C.)

24566 THE EFFECT OF THE PRE-IRRADIATION ON THE SCINTILLATION PROPERTIES OF NaI(Tl) CRYSTALS. Z. B. Baturicheva, N. Yu. Gurevich, and Yu. A. Tsirlin. Opt. Spectry. (USSR)(English Transl.), 18: 73-4 (Jan. 1965). Translated from Optika i Spektroskopiya, 18: 139-41(Jan. 1965).

The effects of prior irradiation (x rays or γ rays from ^{60}Co) on the response of NaI(Tl) single crystals (0.07% Tl) to a ^{137}Cs γ source were studied. It was found that the prior irradiation leads to a reduction of light output and an improvement in resolution. The effect is hypothesized to be due to the formation of thallium trapping centers and the consequent reduction of the number of Tl^+ centers. (D.L.C.)

24567 DESTRUCTION OF F CENTERS BY X RAYS IN PURE AND ACTIVATED KCl CRYSTALS. I. Ya. Melik-Gaykazyan and M. M. Arinshtein. Opt. Spectry. (USSR) (English Transl.), 18: 95-6(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 171-2(Jan. 1965).

An attempt was made to follow the process of the destruction of F centers on changing from "soft" to "hard" x rays. KCl, KCl−Sr, and KCl−Pb were used. The results indicate that if the crystal attains a saturation concentration of F centers on irradiation by "soft" x rays, then "hard" x rays will destroy them. The effect of the dopant and its concentration on the F centers is discussed. (D.L.C.)

24568 ELECTRON PARAMAGNETIC RESONANCE IN IRRADIATED CHLORATES. G. I. Subbotin. Opt. Spectry. (USSR) (English Transl.), 18: 98-9(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 175-7(Jan. 1965).

The structure and regression rates of defects in polycrystalline x-irradiated K, Na, Ca, Mg, Sr, and Ba chlorates were studied using electron paramagnetic resonance. The g-factors for the paramagnetic defects O_2^- and $ClO-ClO_3^-$ were determined and found to coincide for the divalent metal chlorates. The O_2^- centers were found to regress rapidly, and it is suggested that the $ClO-ClO_3^-$ ion is responsible for the coloring of the chlorates. (D.L.C.)

24569 THE STUDY OF LIFETIMES OF POSITRONIUM IN TEFLON IRRADIATED BY GAMMA RAYS. G. Chandra, V. G. Kulkarni, R. G. Lagu, A. V. Patankar, and B. V. Thosar (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 16: 40-1(May 1, 1965).

A correlation between the quenching of the triplet state of positronium and the free radical concentration produced by

irradiating 1 mm thick discs of commercial teflon in a 22.5 kC cell of ^{60}Co is reported. The lifetimes of positronium atoms in different samples were measured by a conventional slow fast coincidence arrangement and a multichannel analyzer detecting the 1280-kev gamma ray from ^{22}Na in coincidence with the 511-kev annihilation gamma. Curves showing the spin concentration in irradiated teflon and the degree of quenching versus the dose of gamma irradiation are presented. (L.B.S.)

24570 CADMIUM SULPHIDE d.c. CONDUCTIVITY CELLS FOR GAMMA RAY DETECTION. L. C. Baker and P. D. Buckingham (Hammersmith Hospital, London). Phys. Med. Biol., 10: 201-8(Apr. 1965).

Very simple radiation monitors can be constructed using only a cadmium sulfide cell, a battery, and a microammeter. The construction of a versatile prototype unit is described, together with the development of monitors for detecting the transfer of radioactivity in radiochemical processes and portable ratemeters for localizing millicurie quantities in vivo. The limitations of the direct current use of CdS cells are discussed and some further applications within these limitations are listed. (auth)

24571 EFFECT OF THE ADDITION OF SATURATED HYDROCARBONS ON THE RADIATION POLYMERIZATION OF ETHYLENE. V. F. Gromov, P. M. Khomikovskii, and A. D. Abkin. Plasticheskie Massy, No. 11, 13-14(1964).

The production of soluble polyethylene with satisfactory mechanical properties by radioinduced polymerization in the presence of low-molecular-weight saturated hydrocarbons was investigated. Heptane and cyclohexane were used as additives and ^{60}Co as a radiation source. The experiment was carried out at 20°C and 400 atm with 3 to 24% heptane and a radiation dose of 65 rad/sec. The effect of the heptane content on the rate of polymerization and the molecular weight and properties of the resulting polymers was studied. Tabulated data showed that for the same ethylene concentrations, increasing the heptane concentration increased the rate of polymerization considerably (especially at more than 6% heptane) and decreased the molecular weight (intrinsic viscosity). The variation in polymer yield with irradiation time at 9.0 to 9.7% heptane content is plotted. In the presence of heptane, completely soluble polymers were obtained up to a degree of conversion of 70 to 80%, while radioinduced polyethylene prepared without additives contained insoluble fractions at a degree of conversion of only 30 to 50% and had a very low fluidity. The tensile strength depended slightly on the heptane concentration and remained in the range of 170 to 246 kg/cm^2. The elongation at break was increased by an average of 600 to 700% as the heptane content increased from 3 to 10 wt %, but decreased considerable above 11 to 23% heptane. At about 10% heptane, the density was 0.96 and did not differ from that of polyethylene prepared without additives. With cyclohexane the best properties were obtained at 6.5% cyclohexane in the initial mixture. The radioinduced polymerization of ethylene was accompanied by the radiolysis of the polymer, which led to the formation of branched and cross-linked polymers. Radioinduced polyethylene had a higher density and crystallinity than the low-pressure polyethylene. It was found that, in order to reduce the reactions leading to cross-linking during the radioinduced polymerization of ethylene, low-molecular-weight saturated hydrocarbons in an amount of 5 to 10% are very effective additives, resulting in polymers with good mechanical and flow properties. (CFSTI)

24572 NATURE OF THE LATENT DAMAGED STATE OF IRRADIATED TRYPSIN. INVESTIGATION BY EPR METHOD. V. N. Luzikov and T. V. Troshkina (Inst. of Chemical Physics, Moscow). Radiobiologiya, 5: 312-13 (1965). (In Russian)

Results showed that thermal after-effects observed in trypsin solutions irradiated by uv light and x rays cannot be explained by the theories of the radical nature of the latent damaged state. (tr-auth)

24573 CHROMATE DOSIMETER. Takuo Asai and Sakiko Ikeguchi (Radiation Center of Osaka Prefecture, Japan). Radioisotopes (Tokyo), 14: 73-7(Mar. 1965). (In Japanese)

A new chemical dosimeter utilizing $K_2Cr_2O_7 \cdot H_2SO_4$ is described. The decrease of extinction of γ irradiated $K_2Cr_2O_7$ were measured in the wavelength of 435 and 350 millimicron. Decrease of extinction was found to be proportional to radiation dose and independent of dose rate. The G-value was 0.446 ± 0.023. In the dose range of $10^4 \sim 10^7$ R, properly prepared solutions of this system can offer reliable results. The reactions in this system are relatively stable, so the total dose in the divided irradiation is also measurable. (auth)

24574 PULSE RADIOLYSIS OF DIOXANE SOLUTIONS. J. H. Baxendale, E. M. Fielden, and J. P. Keene (Univ. of Manchester, Eng.). Science, 148: 637-8(Apr. 30, 1965).

Liquid dioxane gave transient absorptions owing to the production of free radicals and solvated electrons when subjected to a pulse of high-energy electrons (4 Mev for a duration of 2 μsec. Solutions of benzophenone gave the ketyl radical and ketyl radical ions. Solutions of anthracene give anthracene in the triplet state and the anthracene anion. The formation of these species was largely prevented when hydrochloric acid was present. (auth)

24575 ELECTRON SPIN RESONANCE OF IRRADIATED DNA. R. G. Shulman and P. S. Pershan (Bell Telephone Labs., Murray Hill, N. J.). Trans. N. Y. Acad. Sci., 27: 210-14(Dec. 1964).

Results of an electron spin resonance study of the thymic radical in irradiated DNA are presented. Ultraviolet light was used to irradiate the DNA. The derivative of the absorption intensity of the ESR spectra was plotted versus the external magnetic field. Studies with deuterated thymine confirmed that the Zeeman splitting of the spectra dose arise from the methyl protons. It was concluded by comparison of the spectra that the same radical is observed in irradiated DNA as in irradiated thymine. (M.C.G.)

24576 RADIATIONAL SYNTHESIS OF THE COPOLYMER ALLYLAMINE-METHACRYLIC ACID. G. V. Gurash, A. P. Meleshevich, V. Ya. Pochinok, V. G. Syromyatnikov, and I. P. Fedorova (Kiev State Univ. and Pisarzhevskii Inst of Physical Chemistry, Ukrainian SSR). Ukr. Khim. Zh., 31: 89-93(1965). (In Russian)

Copolymers of allylamine with methacrylic acid with the properties of polyampholytes were prepared for the first time by radiation synthesis. The composition and structure of the copolymers were determined by chemical and spectral methods of analysis. (tr-auth)

24577 THE EFFECT OF γ RADIATION FROM Co^{60} ON SUBSTITUTED POLYSTYRENES. V. V. Antuf'ev, A. F. Dokukina, M. P. Votinov, E. V. Suntsov, and A. G. Boldyrev. Vysokomolekul. Soedin., 7: 380-4(Mar. 1965). (In Russian)

The effect of γ radiation on polystyrene, one of the most radiation-resistant polymers, and on substituted polystyrenes (substituents: CH_3, Br, Cl, and F) was investigated. Quartz ampuls were filled with granulated polystyrene samples, evacuated to approximately 10^{-4} mm Hg, and sealed. They were then exposed to a ^{60}Co source and received total doses of 0 to 16 Mr. Their EPR spectra were taken at 77 and 300°K, 2 hr, 1 week, and 1 month after irradiation. No noticeable changes in properties were observed with variations in storage time. Changes in the polymer structure were deduced from the solubility of the irradiated samples in benzene. It was found that the radical yield from radiolysis depends substantially on the nature and position of styrene substituents, e.g., the yield from methylstyrene was 0.5 orders of magnitude larger than that from styrene. (CFSTI)

24578 ENERGY TRANSPORT IN SOLUTIONS: SCINTILLATION OF ARYL-SUBSTITUTED IMIDAZOLE. Manfred Wilk and Karl-Heinz Peters (Universitat, Frankfurt am Main). Z. Naturforsch., 20a: 401-8(Mar. 1965). (In German)

Investigations were made of energy transfer in liquid scintillators under uv and β-excitation. The effects of n-

hexane and methanol and diluting solvents on the scintillation process in p-terphenyl-toluene were measured. Differences of energy transfer under β and uv irradiation are discussed. Radiationless energy transfer occurred over distances from 15 to 32 Å. Quenching effects of phenol on p-terphenyl, 2,5-diphenyl-oxazole, and 2,4(or 5)-diphenyl-imidazole were studied. Oxygen-quenching in liquid scintillators containing hydroxybenzenes was investigated. The results corresponded with the Kallmann-mechanism of radiationless energy transfer. Further investigations were made of the connection between the chemical structure of aryl-imidazoles and their scintillation properties. Scintillation properties depended on spectral data. The results proved Heller's postulates, concerning structural requirements for good scintillation properties of organic liquid scintillators. (auth)

24579 RADIATION CHEMISTRY OF CARBOHYDRATES. II. NEW DATA ON GLUCOSE, GALACTOSE, AND MANNOSE RADIOLYSIS. N. K. Kochetov, L. I. Kudryashov, S. M. Yarovaya, and E. I. Bortsova. Zh. Obshch. Khim., 35: 268-72(Feb. 1965). (In Russian)

It was found that for aqueous solutions of glucose, mannose, and galactose the decomposition yield increases with increasing concentrations of the original monosaccharides in the concentration limits from 5×10^{-3} to 10^{-1} M. It was found that the radiation stability of glucose, mannose, and galactose was the same. Comparison of the results obtained with data from the literature showed that, in the dose and concentration range studied, practically identical results were obtained. (tr-auth)

24580 RADIATION CHLORINATION OF ETHYLTRICHLOROSILANE, METHYLTRICHLOROSILANE AND DIMETHYLDICHLOROSILANE. M. T. Filippov, R. V. Dzhagatspanyan, G. V. Motsarev, and V. I. Zetkhin. Zh. Vses. Khim. Obshchestva im. D. I. Mendeleeva, 9: 475-6(1964).

The reaction mechanism of radiation-initiated chlorination of alkyl-chlorosilanes was studied. Liquid phase ^{60}Co radiation-initiated chlorination of ethyltrichlorosilane with molar ratios of Cl/silane ranging from 0.15 to 0.35 resulted in the formation of α and β monochloro derivatives only, with the proportion of $\beta:\alpha = 1.72$ when the reactant ratio was 0.26 or 0.35, and $\beta:\alpha = 1$ when the reactant ratio = 0.15 or 0.18. Chlorination of methyltrichlorsilane with Cl/silane molar ratios ranging from 0.20 to 0.81 gave about 9% $CH_2ClSiCl_3$, and a total concentration of higher chloro derivates approximately proportional to the solar ratio. Changing the dose rate from 1 to 50 rad/sec had no effect on the product. Lowering the temperature from 20 to 0°C lowered overall yield slightly but increased the yield of polychloro derivatives. Air retarded the reaction. A radical chain mechanism is discussed for the radioinduced chlorination of methyltrichlorosilane wherein the rate of formation of $CH_2ClSiCl_3$ and overall reaction is determined by the reaction $CH_3SiCl_3 + Cl \rightarrow \cdot CH_2SiCl_3 + HCl$, and the rate of its disappearance is determined by the reaction $ClCH_2SiCl_3 + Cl \rightarrow \cdot CHClSiCl_3 + HCl$. $CH_2ClSiCl_3$ was chlorinated about 10 times faster than CH_3SiCl_3; increasing the temperature from 0 to 24.4°C increased this chlorination rate about 3 times; the energy of activation was about 7300 cal/mol. The same general rules applied to the chlorination of dimethyldichlorosilane as to methyltrichlorosilane; the rate of the dimethyldichlorosilane chlorination at 0°C was 19 times faster than for chlorinating methyltrichlorosilane; its energy of activation was 6100 cal/mol. The effects of the Cl/silane ratio in radiation chlorination were the same as in chemically initiated chlorination; the same rules and the radical chain mechanism of photochemically and chemically initiated chlorination were good for radioinduced chlorination. (CFSTI)

24581 RADIATION EFFECTS IN ATACTIC AND ISOTACTIC POLY(PROPYLENE OXIDE). George Philip Roberts. Thesis, Evanston, Ill., Northwestern Univ., 1964. 168p.

The chemical effects of high-energy gamma rays on isotactic, atactic, and optically active poly(propylene oxide) were investigated. The polymer samples were obtained by polymerizing propylene oxide, using a diethyl zinc–water cocatalyst system. D-(-)-propylene oxide was synthesized and used in the preparation of the optically active polymer. The isotactic polymer was separated from the atactic by a fractional crystallization from an acetone solution of the whole polymer. Irradiations were all carried out in vacuo at room temperature using ^{60}Co γ rays. No change was detected in the optical rotatory power of a sample of the optically active material irradiated to 38.4 Mrad. The radiation chemistry of the atactic and isotactic polymer prepared from the racemic monomer was studied over the dose range from 0 to 680 Mrad, depending on the property being investigated. The infrared spectrum, solubility, and intrinsic viscosity were studied as a function of dose for both the atactic and isotactic modifications. The number of moles of gases condensable at –196°C and the number of moles of gases noncondensable at –196°C, evolved during the irradiation, were measured as a function of dose and the compositions were determined by mass spectral analysis. The following radiation yields were found. Atactic: $G(H_2) = 0.97$; $G(CO) = 0.25$; $G(CH_4) = 0.058$; G(gas condensable at –196°C) = 0.13; $G(\geq C = O) = 0$; $G(-\overset{|}{C}-OH) = 1.8$. Isotactic: $G(H_2) = 1.12$; $G(CO) = 0.41$; $G(CH_4) = 0.072$; G(gas condensable at –196°C) = 0.12; $G(\geq C = O) = 0.64$; $G(-\overset{|}{C}-OH) = 3.0$. Charlesby-Pinner plots were made of the gel data, which were analyzed by the methods of Inokuti and Graessley. (A.G.W.)

24582 EXCHANGE REACTIONS OF ALKYL IODIDES AND IODINE. Edward David Cohen. Thesis, Newark, Del., Univ. of Delaware, 1964. 130p.

The thermal exchange reaction of ethyl iodide and iodine was investigated in the liquid phase. The exchange rate was independent of iodine concentration from 10^{-8} to 10^{-3} molar and had an average rate 0.56×10^{-6} M/hr at 23°C. The rate was dependent on the ethyl iodide concentration and may be expressed by $R = k(EtI)^2$. This rate law was applicable from 0 to 40°C. Isopropyl iodide was found to exchange with a similar rate law but at a significantly lower rate. There was some indication of an heterogeneous process, but it was found only with glass surfaces and was not considered to be a predominant factor in this exchange. An induction period was observed in some of the exchange runs. This was attributed to an iodine-131 impurity which retarded the exchange. The rate-controlling step of this exchange postulates the slow formation of an activated complex of two molecules of ethyl iodide. The activated complex then undergoes a rapid exchange with iodine and dissociation of the complex leads to the exchanged molecule. Two possible structures are proposed for the activated complex. The first is a cyclic structure, which is held together by hydrogen bonds and gains extra stability from the six-membered ring present. The second is a diethyl iodonium iodide species in which an ion pair is formed. Upon considering the activation energy of 21.5 kcal and the entropy of activation, -42 eu, the diethyl iodonium iodide was favored. This unusual mechanism and the induction period can account for the irreproducibility noted in studies on this system. The iodine independence of the exchange and the magnitude of the rate at room temperature could explain the retention in the Szilard-Chalmers effect. The induced exchange rate was studied by ^{60}Co irradiation and the results are consistent with the proposed mechanism for the radiation processes in this system. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24583 RADIATION COPOLYMERIZATION OF STYRENE AND SULFUR DIOXIDE. Lowell Yemin. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 165p.

The copolymerization of styrene and sulfur dioxide, initiated by gamma radiation, was studied over a temperature range of –21 to 95°C at a radiation dose rate of about 1400 rad/min. The reaction was carried out without the use of solvents in sealed, heavy-wall glass tubes. Reaction rates were determined from the weight and composition of the recovered polymer. The solubility of the polymers in

benzene was determined as well as the heat stability of several selected samples. The kinetic and composition data were correlated by a free radical mechanism that assumes repulsion toward SO_2 molecules by polymeric SO_2 units in the penultimate position and reversibility of the propagation steps involving formation of styrene-SO_2 bonds. The most detailed work was done at 0°C with SO_2/styrene molar ratios ranging from 0.03 to 1.1. Almost all of these runs were limited to less than 2% conversion. At other temperatures the reactant composition was varied over a narrower range. An Arrhenius plot of the reaction rate of SO_2 shows a change in slope at about 10°C, indicating a predicted change in mechanism. Above 50°C the slope steadily decreases. The rate of conversion of styrene, however, continues to increase steadily. The same effect is seen in the polymer composition, which is shown to be a function both of temperature and reactant composition. The compositions ranged from 14.6% (by weight) sulfur at −21°C to 5.4% at 95°C. Polymers containing less than 9.0% sulfur were soluble in benzene. Those containing more than 11.0% were insoluble except for partial solubility of those polymers containing polystyrene from a competing ionic reaction. (Dissertation Abstr., 25: No. 6, Dec. 1964)

24584 EVALUATION OF ELECTRICAL INSULATION FOR RADIATION TOLERANT EQUIPMENT. C. L. Craig and J. Rogers (Sperry Rand Corp., Great Neck, N. Y.). 17p. (CONF-769-10)

From Conference on Electrical Insulation, Cleveland, Oct. 1964.

Studies were made to establish a gamma-neutron relationship that would, when the individual neutron flux and gamma dosage is known, allow an estimation of effects on a material from a mixed radiation environment. Samples of commercially available electric insulating materials were exposed to mixed radiation in reactor. Temperatures were kept constant and relatively low (50 ± 10°C) to reduce thermal degradation variations and dosimetry rate effects. Insulating films, coated sheets, sleeving and tubing, plastics, magnet wire insulation, hook-up wire, and impregnations and encapsulants were Investigated for radioinduced changes in critical properties. Tensile strength and dielectric strength of the irradiated materials were determined. Results are presented in tables. (M.C.G.)

24585 MÖSSBAUER RESONANCE IN IRON-CONTAINING BIOCHEMICALS. R. E. Johnston and D. A. Waite (Vanderbilt Univ., Nashville). 3p. (CONF-641114-3)

From American Physical Society, Southeastern Section, Chattanooga.

A linear velocity device was constructed for the purpose of carrying Mössbauer absorbers at a preset uniform velocity. The detector is a proportional counter filled with a Xe–CH_4 mixture at 1 atm connected to a single-channel pulse height analyzer. Some biochemical compounds containing iron were studied. The Mössbauer resonance spectra of ferritin, ferrous fumarate, iron dextran, and ironized yeast are discussed. (M.C.G.)

24586 RADIATION-INDUCED CHEMICAL REACTIONS. J. W. Hodgins. 24p. (CONF-650216-1)

From American Nuclear Society, Niagara Finger Lakes Section Meeting, Toronto.

Features associated with the use of high-energy radiation for the initiation of chemical reactions, which make the chemistry of such reactions very difficult, are: the enormous surfeit of energy in the photon, the non-specific character of radiolysis, and the complexity of reactions that occur. Reasons for using high-energy gamma radiation for initiating chemical reactions are outlined. The use of gamma energy to initiate the graft polymerization of styrene to cellulose in wood is described. It was found that water must be employed if grafting is achieved and that the weakening effect of the water outweighs the strength contribution of the graft co-polymer. The radio-induced chemical chain reaction for chlorination of methane is described. The gamma-initiated liquid-phase reaction between ammonia and benzene to yield aniline is also described. (M.C.G.)

Radiochemistry

See also Separation Processes and Procedures.

Refer also to abstracts 24904 and 24905.

24587 (ANL-6998) THE PURIFICATION OF 10 CURIES OF Cm^{242}. E. P. Horwitz, C. A. A. Bloomquist, H. W. Harvey, D. Cohen, and L. J. Basile (Argonne National Lab., Ill.). Feb. 1965. Contract W-31-109-eng-38. 14p. Dep.; $1.00 (cy), 1(mn) CFSTI.

Ten curies of ^{242}Cm, produced by neutron irradiation of $^{241}AmO_2$, were processed for high decontamination from capsule material, fission products, and chemical reagents, and for moderate decontamination from americium. The equipment and chemical methods used to process the capsule are described. (D.L.C.)

24588 (ORNL-P-1154) POLICY AND PROCEDURES USED IN THE UNITED STATES FOR DECONTAMINATING HOT CELLS. Clyde D. Watson (Oak Ridge National Lab., Tenn.); Ernest A. Berreth (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Jerome E. Dummer (Los Alamos Scientific Lab., Univ. of California, N. Mex.); Ross K. Fuller (Naval Radiological Defense Lab., San Francisco, Calif.); and Robert F. Stearns (General Electric Co., [Pleasanton, Calif.] Vallecitos Atomic Lab.). [1965]. Contract W-7405-eng-26. 19p. (CONF-650604-3). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Working Methods in High Activity Hot Labs., Grenoble, France.

In the United States, hot cells and equipment for handling radioactive solids or liquids are successfully decontaminated as required. The frequency varies from about three times a year to only once in three years for the larger pilot plant units. The normal time required to decontaminate a facility is about two to six weeks. Decontamination is usually done remotely, through appropriate design, precontamination application of protective coatings, expendable equipment, the proper choice of cleaning reagents (detergents, organic solvents, acids, alkalies, chelating agents), and physical methods (grinding, ultrasonic cleaning, blasting, and abrading). Methods have been developed and are presented for decontaminating hot-cells and adjacent areas subjected to the uncontrolled release of radioactivity. (auth)

24589 SAFER METHOD FOR PREPARING RADIOACTIVE LIQUID SAMPLES FOR WELL COUNTING. Katharine L. Beck and Allen Silbergleit (Veterans Administration Hospital, Dearborn, Mich.). Am. J. Clin. Pathol., 42: 637-9(Dec. 1964).

Minimizing radioactive contamination that results from spillage of radioactive liquid samples in an automatic sample changer is discussed. A sample changer with 100-tube capacity and central well was used to count liquid samples containing ^{57}Co-labeled vitamin B_{12}. The problem of spillage of liquid causing an increasingly high radioactive background was encountered. Glass tubes were subject to occasional accidental breakage by the sample changer, and disposable plastic tubes were occasionally found to leak fluid through very fine, nearly invisible cracks. It was found that one or two cotton balls placed in a tube absorbed the liquid sample and effectively prevented contamination in the event of damage to the tube. The buttressing effect of the cotton resulted in less damage to the tube. Differences between counts with and without the cotton were small, as compared with the standard deviation. Other samples studied with various volumes of fluid and various amounts of radioactivity showed no significant difference in counts with or without cotton balls in the tubes. (BBB)

24590 MEASUREMENTS OF RADIOACTIVITY FROM THE SURFACE OF AQUEOUS SOLUTIONS. M. A. Belokurova, N. E. Tsvetaeva, M. N. Kulichenko, and L. A. Ivanova. At. Energ. (USSR), 18: 296-8(Mar. 1965). (In Russian)

The surface radioactivity from the aqueous salt solu-

tions of ^{144}Ce, ^{210}Po, and ^{239}Pu was measured in order to determine the dependence of surface α- and β radioactivity on the isotopic concentration in a volume of the solution and its concentration at the liquid-air boundary. The activity of ^{144}Ce salt solution with 0.1 mmole NaCl increased with the acidity of the solution. The radioactivity of ^{144}Ce solutions at pH = 6 increased with higher isotopic concentration. Application of 300 mg/cm^2 aluminum plate absorbed soft β components of ^{144}Ce and sharply reduced the activity. Acidification of the solution to pH = 1 to 4 increased the counting rate of activity which did not change with time. The α activity from the surface of nitrate aqueous solution of ^{210}Po with 2.4×10^{-4} C/l concentration (2.6×10^{-10} g/atom.l) at pH = 6 to 7 increased about threefold in comparison to polonium solution in 1.5N HNO_3. It was calculated that for pH = 6 to 7 the concentration of ^{210}Po in the surface layer is 10^5 to 10^6 times larger than in the volume. With ^{239}Pu it was found that filtration of plutonium solutions renders higher activity. The results suggested that acidification of Ce, Po, and Pu solutions and filtration of Pu produce more accurate count and screening of soft β radiation in radioisotopes with hard and soft β radiation improved the counting of the activity. (R.V.J.)

24591 INVESTIGATION OF RADIOACTIVE IODINE SORPTION BY ACTIVATED CARBON AND STUDIES OF SHAPES OF GASEOUS IODINE IN THE AIR. T. N. Smolkina and A. A. Chubakov. At. Energ. (USSR), 18: 298-9(Mar. 1965). (In Russian)

Sorption of gaseous iodine emitted with the air current from a fuel element heated at 900 to 1000°C by BAU carbon at an air current rate of 20 cm/sec was investigated. The fuel element was prepared with uranium enriched beryllium oxide without anti-fragment coating. The concentration of radioactive iodine was 10^{-9} to 10^{-11} C/l. The graphs of gaseous iodine concentration along the BAU carbon showed that 10 cm of BAU layer could reduce the concentration of iodine in the air about 500 times. The experimental data revealed the presence of three forms of iodine: elementary iodine, iodides, and iodates, and possibly other mixtures with positive valence iodine. With the fuel element temperature increase the percentage of iodides in the iodine vapor mixture slowly decreased; the percentage of the third form of iodine vapors first dropped down then reached a constant level at ~0.5 to 1%. The largest amount of iodine vapor mixture was observed at 100 to 200°C (75%) with 25% of the third form. (R.V.J.)

24592 ON THE CURIE LEVEL PREPARATION OF ^{147}Pm FOR THE RADIOGRAPHIC INVESTIGATION OF THE HOMOGENEITY OF URANIUM-GRAPHITE REACTOR FUEL. H. Bildstein, W. Parker, and H. Riedl (Osterreichische, Studiengesellschaft fur Atomenergie, Seibersdorf, Austria). Atompraxis., 11: 155-66(Mar. 1965).

The preparation of a compact bremsstrahlung source used for the determination of the homogeneity of uranium-graphite reactor fuel mixtures is described. Such reactor fuel is used in reactors (dragon) of the high temperature type and is in the form of a hollow cylinder. The isotope employed, ^{147}Pm, is prepared in the form of a ring type source with a 20 mg/cm^2 gold converter foil and positioned in the center of a chosen section. The radiograph is recorded on a suitable x-ray film previously wrapped round the outside of the fuel section. The device described forms a compact shielded unit which can be handled in a photographic dark room. Typical radiographs are presented showing the uranium distribution for fuel elements and for different exposure times. (auth)

24593 ISOTOPIC EXCHANGE BETWEEN GASEOUS OXYGEN AND SOME URANIUM COMPOUNDS. Vikt. I. Spitsyn and E. G. Lavut (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 159: 626-9(Nov. 21, 1964). (In Russian)

Gaseous oxygen enriched to ~6.5% ^{18}O was used to follow the isotopic exchange in the following uranium compounds: U_3O_8 (6.6), α-$UO_{2.94}$ (9.7), γ-UO_3 (0.60), amorphous UO_3 (22.5), $Na_2U_2O_7$ (0.26) calcined at 1000°C, $Na_2U_2O_7$ (1.14), β-Na_2UO_4 (0.44), and α-Na_2UO_4 (0.92). The numbers in parentheses refer to the specific surface in m^2/g as determined according to the BET method by krypton absorption. All the experiments except two with α-Na_2UO_4 and one with amorphous UO_3 were carried out at a ratio of gram-atoms of O_2 in the solid n_s to that in the gas phase (ng) equal to $s = n_s/n_g = 3.707 \pm 0.030$. A plot of lg (1-F) versus time, t, is linear except for value of the exchange $F > 90\%$, and for slow diffusion processes. The exchange activation energies in kcal/mole were found to be 41.6 ± 0.7 (450 to 525°C) for U_3O_8, 39.0 ± 2.1 (375 to 475°) for α-$UO_{2.94}$, 32.0 ± 2.3 (675 to 775°C) for $Na_2U_2O_7$ (calcined at 1000°C), 26.0 ± 2.1 (500-700) for $Na_2U_2O_7$, and 20.1 ± 2.7 (500-650°C) for β-Na_2UO_4. The self-diffusion activation energies in kcal/mole were 72 ± 16 (600-650°C) for γ-UO_3, 51.0 ± 4.0 (500-700°C) for $Na_2U_2O_7$, 26.9 ± 1.4 (400-650°C) for β-Na_2UO_4, and 32.4 ± 3.5 (500-700°C) for α-Na_2UO_4 at temperature intervals indicated. (TTT)

24594 ^{131}I-LABELED BOVINE THYROTROPIN: PREPARATION THROUGH A NEW MICRO TECHNIQUE OF IODINE DISTILLATION AND STUDIES OF ADSORPTION TO GLASS AND POLYETHYLENE. M. Lawrence Heideman, Jr., Richard P. Levy, William L. McGuire, and Reginald A. Shipley (Veterans Administration Hospital, Cleveland and Western Reserve Univ., Cleveland). Endocrinology, 76: 828-38(May 1965).

Purified (15-35 USP U/mg) bovine TSH preparations dissolved in pH 8, 0.2M, sodium borate buffer were labeled through $^{131}I_2$ distillation, accomplished by controlled bubbling of air and gentle heating. Iodide was removed by dialysis. Good yields (% labeling) were achieved with calculated ratios of 0.75-2.4 I atoms per TSH molecule. Biological activity of ^{131}I-TSH was not significantly less than that of control TSH carried through the procedures except for distillation-iodination, but both were usually significantly (up to ca 50%) less than that of undialyzed standard (starting) TSH. Liquid solutions of ^{131}I-TSH in pH 7.2-7.4 Krebs-Ringer phosphate medium (KRP) lost radioactivity and biological activity onto polyethylene or glass containers substantially in a few hours. The presence of 0.25% human serum albumin (HSA) prevented these losses. In all cases paper chromatography revealed no significant breakdown of labeled protein, and there was no loss of total radioactivity: solution + container. HSA-containing KRP, with stirring, effectively eluted from glass both biological activity and radioactivity that had been adsorbed from liquid solutions in plain KRP during brief standing, but similar elution after plain solutions had stood 5 days was less effective with glass and poor with polyethylene. Frozen solutions of ^{131}I-TSH in KRP with 0.025% HSA and 0.001M propylthiouracil were quite stable, and negligible or slow losses occurred from frozen solutions in plain KRP. Losses on thawing were attributable to standing in liquid solution. (auth)

24595 DEUTERIUM ISOTOPE EFFECT IN PROTON-^{13}C COUPLING CONSTANTS. Gideon Fraenkel (Ohio State Univ., Columbus) and William Burlant. J. Chem. Phys., 42: 3724-5(May 15, 1965).

The NMR spectra of spectral deuterated organic compounds were determined and found to be of first order. In each case the extra multiplicity due to H,D coupling could be eliminated by irradiating the sample at 9.42 Mc/sec during the determination of the hydrogen spectrum. It was found that substitution of D for H has a very minor effect on the chemical shifts of the remaining hydrogens in the molecule. In contrast to the chemical shift data there is an increase in the ^{13}C-hydrogen coupling constant when a hydrogen on ^{13}C is substituted by deuterium. It was concluded that since deuterium as a substituent has a Malinowski parameter of about 4 cps, other effects also contribute to $J_{^{13}C,H}$. (P.C.H.)

24596 ON THE EXCHANGE REACTION $^{16}O + {}^{18}O_2$. W. Brennen and H. Niki (Harvard Univ., Cambridge). J. Chem. Phys., 42: 3725-6(May 15, 1965).

Direct measurement was made of the exchange-rate constant for the reaction $^{16}O + {}^{18}O_2$ molecules, at room temperature. Both atomic and molecular species were monitored with a time-of-flight mass spectrometer oper-

ated at 20 ev electron beam energy. At 10^{-4} Torr partial pressure of ^{16}O atoms in the flow system virtually no $^{16}O_2$ mass peak was detected. Starting with comparable concentrations of ^{16}O and $^{18}O_2$, the decay of the $^{18}O_2$ mass peak was measured as a function of the reaction time. A second-order plotting of the time dependence of ($^{18}O_2$) at the initial stage of the reaction was used to deduce a value of $k = 1.7 \times 10^{-(12\pm0.2)}$cc molecule^{-1} sec^{-1} for the reaction $^{16}O + {}^{18}O_2 \rightarrow {}^{16}O{}^{18}O + {}^{18}O$. The result means that the exchange occurs about once in every 180 gas kinetic collisions, and that the activation energy for the reaction is at most 3.1 ± 0.3 kcal mole^{-1}. (P.C.H.)

24597 ORGANIC COMPOUNDS LABELLED WITH S^{35}. PART I. SYNTHESIS, PURIFICATION AND PURITY TESTING OF HIGH SPECIFIC ACTIVITY METHIONINE-S^{35}. K. Heise and E. Mittag (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 181-4(Mar. 1965). (In German)

The synthesis of methionine-^{35}S having high specific activity (75 mC per millimole) is described. Methylmercaptan is produced from thiocarbamide-^{35}S which gives 5-(β-methylmercaptoethyl)-hydantoin-^{35}S by reaction with 5-(β-bromethyl)-hydantoin. Saponifying with baryte water yields methionine-^{35}S. Salting-out of amino acid is realized by ionites. The purity of methionine-^{35}S was proved by means of thin-layer chromatography. (auth)

24598 INVESTIGATIONS ON THE PRODUCTION OF ^{125}I. Tamas Lengyel and Istvan Pavlicsek (Orszagos Atomenergia Bizottsag Izotop Intezete, Budapest). Magy. Kem. Folyoirat, 71: 54-6(Feb. 1965). (In Hungarian)

Making use of the $^{124}Xe(n,\gamma)^{125}Xe \xrightarrow{K} {}^{125}I$ reaction, an iodine isotope previously commercially unavailable in Hungary was produced. The employed conditions of irradiation and processing permitted the production of carrier-free ^{125}I in high radiochemical purity. Detection of the extremely soft γ and x rays was accomplished with the aid of scintillation technique; purity was determined by using a single-channel Siemens amplitude analyzer. Investigations regarding the potential diagnostic uses of the product are in progress. (auth)

24599 ACTIVATION ENERGY OF THE ANODIC DEPOSITION OF RADIOACTIVE ELEMENTS. Istvan Madi (Kossuth Lajos Tudomanyegyetem Fizikai-Kemiai Tanszeke, Debrecen, Hungary). Magy. Kem. Folyoirat, 71: 62-8(Feb. 1965). (In Hungarian)

The kinetics of the anodic deposition of ^{144}Ce was studied as a function of the anode voltage and the temperature. The time of the deposition was investigated at a given anode voltage at various temperatures, and the value of the activation energy was determined for a given voltage from the temperature dependence of the rate constants. The voltage dependence of the activation energies was studied by means of measurements carried out at different voltages. The kinetics of the codeposition of radioactive substances (^{144}Ce and ^{212}Pb) was also investigated. It was found that when carrier-free ^{144}Ce and ^{212}Pb are both present in trace quantities they do not influence the deposition of each other, neither kinetically, nor from the point of view of the equilibrium distribution coefficient which characterizes the final result of the deposition. However, if one of the radioactive substances is present in trace quantity, but the concentration of the other is higher, the difference will be significant from the kinetic viewpoint, too. The influence of some organic substances on the anodic deposition of ^{144}Ce and ^{212}Pb was also studied. (auth)

24600 SYNTHESES OF 3-INDOLYL-DERIVATIVES LABELED WITH ^{14}C. Roberto Badiello and Alberto Breccia (Universita, Bologna and CNR, Bologna). Ric. Sci., Rend., Ser. A (2), 6: 357-62(Dec. 1964). (In Italian)

The syntheses of some ^{14}C-labeled indolyl-3 derivatives are described. The compounds are: Gramine, N-carbobenzoxy-tryptophan, 3-indolylaldehyde, 3-indolylglyoxylic acid, 3-indolylacrylic acid, 3-indolylpyruvic acid, and 3-indolylacetamide. (auth)

24601 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF THE SODIUM-24 ISOTOPE. (to Siemens-Schuckertwerke AG). British Patent 978,411. Dec. 23, 1964. Priority date Dec. 12, 1962, Germany.

A method is proposed for the separation of sodium-24 isotope from substances associated with it as a result of its production from aluminum by the reaction $Al^{27}(n,\alpha)^{24}Na$. The substances are heated to a temperature of 1000 to 1100°C in a quartz vessel having a metal lining made of Mo, W, Ta, or Pt in a H_2 or inert gas atmosphere to vaporize the sodium-24 isotope. The vaporized sodium is captured on the metal and then dissolved from the metal surface with acid. (B.L.M.)

Separation Processes and Procedures

See also Analytical Procedures.

Refer also to abstract 25706.

24602 (ANL-6901) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART 5. DESCRIPTION OF A PILOT-SCALE FACILITY FOR URANIUM DIOXIDE–PLUTONIUM DIOXIDE PROCESSING STUDIES. G. J. Vogel, E. L. Carls, and W. J. Mecham (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 104p. Dep.; $3.00(cy), 2(mn) CFSTI.

A pilot plant has been constructed for studying the following two major process steps, as applied to uranium dioxide–plutonium dioxide fuel: (1) the fluorination of uranium and plutonium oxides to hexafluorides, and (2) the conversion of uranium and plutonium hexafluorides to dense dioxide mixtures suitable for refabrication of fuel. A major objective is the demonstration of optimum process conditions for these two steps for synthetic reactor fuel compositions, including those containing mixtures of inactive fission products. The conversion unit can also be used for separating uranium and plutonium by selective reduction of plutonium hexafluoride from hexafluoride mixtures. The nominal throughput of the pilot plant is 10 kg/day. Current experimental work involves the testing of equipment with uranium only. After successful demonstration runs, work with plutonium will commence. UO_2–PuO_2 pellets, immersed in a fluidized bed of alumina, will constitute the charge to the fluorinator. The hexafluorides can be formed by either simultaneous oxidation (which disintegrates the pellets) and fluorination, or by batch oxidation followed by fluorination. The reactor walls at the fluorination zone are kept at a constant temperature of about 500°C by externally attached cooling coils through which a two-phase, air–water mixture is passed. Process gas from the fluorination zone passes through a disengaging section and a cooled porous-metal filter at the top of the fluorinator unit. The product hexafluorides are condensed out of the gas stream in a condenser cooled to −70°C by a circulating heat-transfer liquid. The fluorinator is made of nickel. Monel is also used for equipment and components of the fluorinator system that operate at lower temperatures. Waste streams in this step are the solid nonvolatile residues in the fluorinator and the noncondensible gases leaving the condenser. The fluoride content of the waste gas is removed from the gas stream by a bed of activated alumina before the waste gas is sent to the exhaust-air treatment. Hexafluorides are converted to dioxides by reaction of the hexafluoride vapor with steam and hydrogen at about 600°C in a fluid bed of the product dioxide. The product is recovered as fluidizable particles and drained from the Inconel converter. Effluent gaseous wastes are filtered and water-scrubbed before the gas is sent to the exhaust-air treatment. The major process equipment is mounted in a large glovebox for containment of the toxic, alpha-emitting plutonium. Auxiliary equipment is housed in a smaller glovebox. An air purge maintains the alpha box under pressure negative to that in the personnel area. The chief hazard will be the possibility of volatile plutonium hexafluoride being released from the process equipment. To remove such material from the air exhausted from the alpha boxes, this air is passed through water scrubbers

to hydrolyze any hexafluoride to nonvolatile material; multiple, high-efficiency filters then remove solids from the exhaust air before final venting to the atmosphere. Special features of the installation concern the adaptation of equipment, gas supplies, utilities, material handling, and instrumentation and control to alpha-box operation. A remote panelboard is provided for instruments measuring temperature, pressure, gas flow and composition, and product collection. Control during runs, including valve operation, is also carried on from the panelboard. Material movement and equipment maintenance are done manually by special glovebox techniques. (auth)

24603 (ANL-6999) NITRIC ACID–ORGANIC SOLVENT MIXTURES FOR SEPARATION OF PLUS-THREE ACTINIDES ON ANION RESINS. I. SURVEY OF SOLVENTS. D. C. Stewart, C. A. A. Bloomquist, and J. P. Faris (Argonne National Lab., Ill.). Feb. 1965. Contract W-31-109-eng-38. 21p. Dep.; $1.00(cy), 2(mn) CFSTI.

More than 60 water-miscible organic solvents were surveyed for use as possible components in mixed solvent–nitric acid elutriants to accomplish transplutonium element separations in anion-exchange resin systems. Several solvents for accomplishing such separations were found, nine of which met preliminary criteria established to determine their suitability for hot-cell use with high levels of radiation. Americium-curium separation factors superior to those of previously reported systems were found in a number of the solvent mixtures. Several solvents were also discovered having promising potentiality for the difficult americium-promethium separation. (auth)

24604 (BNWL-46) PURIFICATION OF STRONTIUM-90 FROM MAGNESIUM. L. A. Bray (Battelle-Northwest, Richland Wash. Pacific Northwest Lab.). Mar. 15, 1965. Contract AT(45-1)-1830. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The D2EHPA solvent extraction behavior of magnesium was measured and found to be identical to that of strontium. Addition of complexing agents (such as DTPA) also failed to result in a change in the relative extractabilities of the two, precluding magnesium separation by this scheme. A precipitation process, utilizing low solubility of magnesium hydroxide, was successfully developed to eliminate magnesium. This process may also be applicable to the final purification step (eliminating the proposed strontium purification using D2FHPA solvent extraction), since calcium, cerium, iron, and rare earths are also precipitated away from the strontium fraction. Less than 5 percent of the magnesium and essentially none of the iron and cerium initially present in the synthetic feed remained in solution at pH 10. Less than 2 percent of the initial strontium was lost below a pH of 11, but the loss increased to 15 percent at a pH of 13. Approximately 98, 51, and 8 percent of the calcium remained in solution as a function of the respective pH values of 11, 12.4 and 13. The final precipitate occupies a volume less than 8 percent that of the original solution and is somewhat gelatinous, but centrifuges well. (auth)

24605 DP-952) STUDIES OF TRAMEX SOLVENT. I. EFFECTS OF MAJOR IMPURITIES IN TERTIARY AMINE EXTRACTANTS. Errol G. Orebaugh (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1965. Contract AT(07-2)-1. 12p. Dep.; $1.00(cy), 1(mn) CFSTI.

Secondary amines were found to be the major impurities in commercial lots of three tertiary amines: "Alamine" 336, "Alamine" 336-S, and "Adogen" 364. These impurities form precipitates or emulsions when the tertiary amines are used as the extractant for americium and curium in the Tramex process. Tenative purchase specifications for Tramex extractant are proposed. (auth)

24606 (HW-71986) INSTRUMENTATION FOR THE SUMMATION OF PLUTONIUM IN A PROCESS STREAM. J. D. Lodge (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 11, 1961. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Plutonium Summation System developed for use in the final product stream at Redox provides a continuous measure of plutonium concentration and of the total plutonium processed during any desired time interval. Basic elements of the system are an electronic flowmeter, a neutron counter for detecting plutonium concentration a multiplier circuit, and an integrating device. An existing electronic flowmeter was utilized by modifying the recorder circuitry to obtain a signal, proportional to flowrate, which could be multiplied by a similar signal proportional to plutonium concentration. The latter signal was generated by a boron trifluoride neutron counter. The two signals are instrumentally multiplied and the product integrated over the desired time period by a mechanical ball, disc, and roller device. Following an initial plant test during the period from April 1960 to June 1961, the system was removed from service and modified to increase sensitivity of neutron detection. The system was placed in operation again in October 1961 and has been performing satisfactorily since that time. Accuracy of measurement of total plutonium flow is within about 5% of results obtained by sampling and laboratory analyses. The overall system is quite reliable in operation and requires only minor routine maintenance. (auth)

24607 (HW-74968) DEVELOPMENT OF SALT-CYCLE PROCESS INSTRUMENTATION. C. E. Huck and O. H. Koski (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 19, 1962. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Instrumentation for analysis and control of key Salt Cycle Process variables is being developed as part of engineering scale studies of the process. The current program includes instrumentation for continuously determining liquid level density, and uranium concentration of the melt, and for integrating ampere-hours during the electrodeposition step. In addition, systems have been devised for controlling the cathode-to-reference electrode voltage both for the primary electrolysis and for a micro-electrode device used to obtain data on pre-electrolysis condition of the melt. Development work is also underway on a versatile control circuit for regulating melt temperature of multiple pots using a single motor generator. (auth)

24608 (HW-75153) DETERMINATION OF PLUTONIUM CONCENTRATION BY NEUTRON COUNTING. J. D. Lodge (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 9, 1962. Contract AT(45-1)-1350. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A series of experiments was performed to determine the applicability of neutron counting for determining plutonium concentration in the Plutonium Reclamation Facility (PRF) columns. Using both organic and aqueous plutonium solutions (up to 28 g/l) in PRF geometries, count rates were measured and instrument performance was evaluated. It is concluded that this technique is suitable for use in the Gradient Control System, although multiple BF_3 detectors, or a more sensitive detector such as the ^3He detector may be required at locations of low concentration. An all-solid-state instrumentation system performed satisfactorily and is recommended for use in PRF. Design of the neutron monitoring system for the Gradient Control System will be based on the results of these experiments. (auth)

24609 (HW-77978) DEVELOPMENT OF A DISSOLVER SOLUTION BOILING POINT MONITOR. O. H. Koski (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 28, 1963. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A continuous boiling point monitor was devised and calibrated. The device consists of a steam-heated vertical tube with a flashing chamber at the upper end. Temperature of the vapor-liquid mixture is measured with a resistance bulb and bridge recorder. Using sodium nitrate solutions of known concentrations, boiling points measurements were made with a repeatability of 0.1 to 0.2°C. Accuracy of the measurements, i.e., the difference between calculated and measured boiling temperatures, ranged from 0.5 to 1.2°C and is dependent upon which of two temperature sensor calibration curves is used. With adequate calibration, a

similar device designed for installation in the Redox dissolver should provide boiling point measurements with sufficient precision to be useful in control of the dissolution process. (auth)

24610 (IDO-14638) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1964. J. R. Bower, ed. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1964. Contract AT(10-1)-205. 34p. Dep.; $0.75(cy), 1(mn) CFSTI.

The ICPP process modifications are described briefly. Dissolution of ATR fuel plates, advanced PWR fuel, and EBR-1 Core 3 fuel was studied separately. Electrolytic dissolution of simulated stainless steel elements was demonstrated. Dissolver system residue deposits were loosened and flushed from the system by hot caustic solution. The corrosion of electrode materials and ceramic coatings was studied. A new ceramic insulator spacer was developed for the electrolytic dissolver. The process and information required for the decontamination of aluminum nitrate wastes by the freeze-melt technique are discussed briefly. The Waste Calcining Facility continued to operate smoothly; off-gas cleanup remains excellent. The design of additional storage facilities is discussed. A study was made of the volatilization of fission products from calcined alumina. Preparation of glass from calcined alumina was also studied. Various plant improvements are considered briefly. (D.L.C.)

24611 (MLM-1227) MOUND LABORATORY PROGRESS REPORT FOR NOVEMBER 1964. J. F. Eichelberger, G. R. Grove, and L. V. Jones (Mound Lab., Miamisburg, Ohio). Nov. 30, 1964. Contract AT-33-1-GEN-53. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Trioctylphosphine oxide (TOPO) is being evaluated as an extractant for the recovery of uranium-234 from large volume waste solutions. In the most extreme conditions for extraction, U losses were less than 4% to the raffinate and less than 3% to the stripped organic (normally recycled). A sample of pure Po metal was prepared from an isotopic mixture of Po-208 and Po-209 for structural studies. X-ray-diffraction patterns of the isotopic mixture were obtained. The decay scheme study for Po-208/Po-209 mixed isotopes was completed. The results of log(ft) calculations together with gamma transition probabilities were combined to determine the decay scheme for Po-208. An analysis of Ac solutions which had been purified by ion exchange revealed the presence of 10–12% nonradioactive impurities. Experiments showed that the impurities could be removed by a second elution on a shorter column than that used originally. The possibility of separating Ca from Ba and Sr was investigated, and a qualitative observation suggests that Ca can be separated from Na as well. Theories of (α,n) reactions indicate that nuclides whose atomic numbers and weights are equivalent to an integer number of alpha particles plus a neutron should be good neutron producers under alpha bombardment. In this respect, studies were started on the neutron yields from C-13, O-17, Ne-21, O-18, and Ne-22. The 12-column, 8-stage, CH_4 thermal diffusion system has now reached 80% mass 17 after correction of a system leak. A chemical conversion system based on the decomposition of Co over an Fe catalyst is being studied as a means for the preparation of elemental C. The reaction yield has been good; however, the C is contaminated with 3 to 6% Fe. The new boiler-decomposer for the CO_2-carbamate chemical exchange system was successful in reducing the parasitic currents in the amine solution. The separation factor reached 1.10 after 19 hours of system operation. The batch processing of intermediate material to enrich Ne-21 was completed; the peak concentration was 62%. A revised arrangement of four columns in cascade was started up with partially enriched Ne-21 feed. With Ar-36 product of over 99.98% purity being drawn from a four-stage system at 1.8 ml/hr, the concentration of Ar-38 at the bottom of the third stage has increased to 6%. The natural abundance of Ar-38 is 0.06%. The two-stage thermal diffusion cascade was inverted to allow draw-off of the heavy isotope Kr-86. Installation of a new swing unit at the top of the six-stage cascaded thermal diffusion system has improved the transport between the feed tank and the top of the first stage. Preliminary data indicate that the bottom of the sixth stage has reached a Xe-131 concentration of 0.58%. Nearly 90 liters of fission product Xe was processed in the large-scale gas chromatograph. The decontamination factor for Kr-85 was approximately 4000. The program for computing collision integrals on the Control Data 3600 computer was used successfully in a trial calculation. The preliminary results differed considerably, however, from those computed by Mason. In the determination of thermal diffusion transport coefficients, data were collected for the separation factor as a function of flow rate for Ne-20–Ne-22 mixtures. Experimental and theoretical studies of the performance of thermal diffusion columns operating with multi-component mixtures of isotopes are being conducted. In vapor pressure thermometry work limited provisional data were obtained for the thermomolecular pressure differences in equilibrium He-4. A low-temperature still was used to investigate the separation of He-3 from He-4. In batch type operation at 1.5°K, the initial product was 66% He-3. Techniques for liquid scintillation counting of tritium in He-3 and Kr-85 in Xe were improved and standardized for greater reproducibility. The use of semiconductor radiation detectors for detecting traces of Kr-85 in Kr is being studied. A rapid potentiometric procedure for the analysis of plating solutions is being investigated. A mixture of cyanide, hydroxide, and carbonate was completely analyzed in a single potentiometric titration with silver nitrate. A nondestructive method of analysis for Fe in elemental C was developed using 14-Mev neutron activation. A rapid, nondestructive method was developed for the analysis of Si in stainless steel by neutron activation. The reaction is $^{28}Si(n,p)^{28}Al$. A rapid analytical method was developed for the determination of SiO_2 in potassium silicate solutions by 14-Mev neutron activation. The precision is ±1.5%. A method for the direct determination of Ni in urine by atomic absorption spectroscopy has been developed. The concentration range of 0.05 ppm was investigated; the absolute accuracy of the determination is ±0.02 ppm. The use of He-3 neutron detectors to monitor trace quantities of He-3 in He-4 is being investigated. In this technique, the response of gas-filled detector (proportional counting chamber) to a neutron source is compared with the known response of a standard gas mixture. A study of the distribution coefficients of NP(IV) and (V) between HNO_3 media and trioctylphosphine oxide-cyclohexane was made. The study indicates that an acidity between 0.1 and 1.0 M HNO_3 is optimum for the separation. The investigation by NMR of trioctylphosphine oxide (TOPO) as a complexing agent was initiated. Evidence was obtained showing that TOPO not only complexes with several U salts but also with some polar organic solvents, such as acetone and benzene. Data analysis of the thorium-228 half-life sample indicated a half life of 1.91313 ± 0.00044 years (internal probable error) for thorium-228 and of 3.665 ± 0.019 days for radium-224. The curing mechanism of an epoxy foam consisting of Epon 828 (Shell Chemical Co.), trimethoxyboroxine (TMB), and diaminodiphenyl sulfone (DDS) is being studied. (auth)

24612 (ORNL-TM-907) MSRE DESIGN AND OPERATIONS REPORT. PART VII. FUEL HANDLING AND PROCESSING PLANT. R. B. Lindauer (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 100p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The MSRE fuel processing system is designed to remove oxides from the fuel, flush, and coolant salts and to recover U from fuel and flush salts. A H_2–HF treatment is used for the oxide removal, while U is recovered by fluoride voltilization. A description is given of the process and equipment. A safety analysis and the operating procedures are included. (D.L.C.)

24613 (ORNL-TM-1092) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, JANUARY 1965. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Procedures and equipment are being developed for the remote operation to be used in the Thorium–Uranium Recycle Facility (TURF). Replacement of alpha windows and use of a TV camera to view all areas which are not directly visible were tested in a cell mockup. Extraction of nitrate from thorium nitrate solutions by long-chain amines gave thoria sols. When these sols were dried to gels and calcined, the ThO_2 products had densities of up to 9.86 g/cc and surface areas as low as 0.005 m^2/g. Development studies in support of the molten salt process have included a thorough investigation of the use of sodium fluoride to absorb uranium hexafluoride. A comparison of the properties of commercial pellets purchased from Harshaw Chemical Co. and pellets produced by a development study at the Paducah Gaseous Diffusion Plant is reported. (auth)

24614 (TRG-Report-902) A REVIEW OF COMPUTER PROGRAMMES FOR SOLVENT EXTRACTION CALCULATIONS. A. L. Mills (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). Dec. 14, 1964. 13p. Dep.; $0.40(BIS); 2s. (HMSO).

Five digital computer programs for solvent extraction have been compared. All the programs use experimentally determined distribution data, and one program is used for the study of dynamics and control of pulse columns. (auth)

24615 DRY PROCESSING OF IRRADIATED FISSIONABLE MATERIALS. M. D'hont. Atoomenergie Haar Toepassingen, 7: 21-7(Feb. 1965). (In Dutch)

In order to avoid the difficulties that arise in the wet processing of irradiated fuel, many investigations were made on dry processing methods. The high-temperature processes (pyrometallurgical and pyrochemical methods) and the chemical processes (halogenates) were surveyed. The advantages and disadvantages are discussed. (J.S.R.)

24616 EXTRACTION OF URANIUM(VI) BY BUTANOL SOLUTION OF BENZOIC ACID. Wei Cheng, Chin-kuang Wu, and Kuang-hsien Ksu. Hua Hsueh Hsueh Pao, 30: 478-87(1964).

A method for determining the stability constants of complexes of the mixed-ligand type was developed and applied to the determination of the stability constants (β_{ij}) of $UO_2A_i(OH)_j$ from distribution data in the extraction of uranium(VI) by benzoic acid in butanol solution. It was found that in the pH range studied there exist five uranyl species in the aqueous phase, UO_2^{++}, UO_2A^+, UO_2A_2, $UO_2(OH)^+$, and $UO_2(OH)A$, where A^- represents the benzoate ion, with the following stability constants: $\beta_{10} = (UO_2A^+)/(UO_2^{++})(A^-) = 8.0 \times 10^2$, $\beta_{01} = (UO_2OH^+)/(UO_2^{++})(OH^-) = 2.0 \times 10^9$, $B_{20} = (UO_2A_2)/(UO_2^{++})(A^-)^2 = 1.8 \times 10^5$, and $\beta_{11} = (UO_2(OH)A)/(UO_2^{++})(OH^-)(A^-) = 5.2 \times 10^{12}$. The distribution constant of benzoic acid between n-butanol and water was determined to be $\Lambda = 58$. (CFSTI)

24617 ANION EXCHANGE SEPARATION OF URANIUM FROM OTHER METALS IN PHOSPHATE SOLUTION. N. P. K. Krishnan and T. K. S. Murthy (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 3: 154-7(Apr. 1965).

Adsorption of uranium (VI) by an anion exchange resin from dilute phosphoric acid and its mixtures with sulfuric, nitric, and hydrochloric acids was studied. It was observed that uranium (VI) is strongly adsorbed from dilute phosphoric acid and that its adsorption decreases with increasing concentration of the other acid in the mixture. For the separation of uranium(VI) from other ions, especially iron (III), which also forms strong phosphate complexes, a mixture containing 0.5M phosphoric acid and 0.25M sulfuric acid was found to be most effective as an eluant. Under these conditions uranium(VI) was strongly held on the column and could be subsequently eluted with hydrochloric acid (2M) and estimated. (auth)

24618 ESTIMATION OF TRACE AMOUNTS OF PROTACTINIUM IN THORIUM NITRATE PRODUCED FROM INDIAN MONAZITE. T. N. V. Pillai (Atomic Energy Establishment, Trombay, India). J. Indian Chem. Soc., 42: 32-4(Jan. 1965).

A practical method was developed to separate trace quantities of Pa from thorium nitrate samples produced from Indian monazite sand using either Dowex-50 for a quantitative separation of Pa or Dowex-1 to afford 80% recovery without any contamination of U in the sample. By a repetition of the method it was possible to isolate radiochemically pure Pa without any contamination with U. This method can be used to prepare an absolute Pa source from uranium ore. (auth)

24619 BIS-(DISUBSTITUTEDPHOSPHINYL)-ALKANES. IV. EXTRACTION OF MINERAL ACIDS, URANIUM(VI), AND SOME LANTHANIDES. J. E. Mrochek and C. V. Banks (Ames Lab., Ames Iowa). J. Inorg. Nucl. Chem., 27: 589-601(Mar. 1965). (IS-818)

Comparative partition data are presented for the solvent extraction of mineral acids, uranium(VI), and some lanthanide elements by bis-(di-n-hexylphosphinyl)-alkanes, $[(C_6H_{13})_2P(O)(CH_2)_nP(O)(C_6H_{13})_2$, where n = 1,2,3,4], as a function of the aqueous concentration of nitric, hydrochloric, and perchloric acids. Extractions from nitric and hydrochloric acids followed quite similar patterns when comparing partition data from the same acid media among the four compounds. However, large increases were noted in the distribution ratios obtained for extractions from perchloric acid with bidentate ligands having methylene carbon bridge lengths, $n \leq 2$. Loading studies, differences in extraction, and visible spectra of the uranium(VI) perchlorate adducts of HDPM (n = 1) and HDPE (n = 2) were interpreted as possibly indicating the formation of disolvated complexes containing two chelate rings. (auth)

24620 BIS-(DISUBSTITUTEDPHOSPHINYL)-ALKANES. V. SOLVATION OF URANYL NITRATE BY BIS-(DI-N-HEXYLPHOSPHINYL)-METHANE, -ETHANE, -PROPANE, -BUTANE, AND BY TRI-N-OCTYLPHOSPHINE OXIDE. J. E. Mrochek, J. W. O'Laughlin, and C. V. Banks (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 603-23(Mar. 1965). (IS-906)

The nature of the complexes existing in solutions of uranyl nitrate and various bifunctional phosphine oxides in several organic diluents (1,2-dichlorobenzene, 1,2-dichloroethane, nitrobenzene, and acetonitrile) was investigated. The bifunctional phosphine oxides studied have the general structure, $R_2-P(O)-(CH_2)-P(O)-R_2$, where R = n-hexyl group and n = 1, 2, 3, 4 for HDPM, HDPE, HDPP and HDPB, respectively. These compounds, like tri-n-octylphosphine oxide (TOPO), are all powerful extractants for many cations. Infrared spectroscopic, partition, conductivity, and viscosity data are given. These data showed that the bifunctional compounds all form monosolvates with uranyl nitrate, which appear to be similar to the disolvate formed by TOPO. In both cases the nitrate groups are strongly coordinated to uranium. Higher solvates are readily formed by the bifunctional compounds with the displacement of one or both nitrate groups from the coordination sphere of uranium. In the case of HDPM and HDPE it appeared that disolvates are formed in which all four phosphoryl groups are symmetrically bonded to the uranyl ion. The appearance of ionic nitrate in solutions containing TOPO in excess of a 2:1 ligand to uranium ratio and of HDPP or HDPB in excess of a 1:1 ratio also indicated higher solvates in these cases. HDPB appeared to form a 3:2 species. Loading capacity data indicated that if the organic phase is equilibrated with an aqueous phase containing a large excess of uranium, the lowest solvates are a disolvate for TOPO and a monosolvate for the bifunctional compounds. If solid uranyl nitrate dihydrate was added to the dry organic phase, the loading capacity indicated that a monosolvate is formed with TOPO and a hemisolvate with the bifunctional compounds. Hemisolvate formation was most extensive with HDPP and HDPB (n = 3,4). (auth)

24621 BIS-(DISUBSTITUTEDPHOSPHINYL)-ALKANES. VI. THE INTERACTION OF BIDENTATE PHOSPHINE OXIDES AND TRI-n-OCTYL PHOSPHINE OXIDE WITH WATER. J. E. Mrochek, J. J. Richard, and C. V. Banks (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 625-9(Mar. 1965). (IS-858)

Proton magnetic resonance and infrared spectroscopic data as well as chemical analyses suggest that bidentate phosphine oxides $[(C_6H_{13})_2P(O)(CH_2)_nP(O)(C_6H_{13})_2$, n = 1, 2, 3, 4] and tri-n-octyl phosphine oxide (TOPO) form complexes with water when dilute solutions (>0.1M) of these compounds in an inert diluent are equilibrated with an aqueous phase. Solubilities of water in the organic phase indicated formation of a monohydrate for bis-(di-n-hexylphosphinyl)-methane (HDPM) (n = 1) and dihydrates for bis-(di-n-hexylphosphinyl)-ethane (HDPE) (n = 2), bis-(di-n-hexylphosphinyl)-propane (HDPP) (n = 3), and bis-(di-n-hexylphosphinyl)-butane (HDPB) (n = 4). Water-solubility data for TOPO indicated formation of a complex with the stoichiometry $H_2O \cdot 2TOPO$. (auth)

24622 BIS-(DISUBSTITUTEDPHOSPHINYL)-ALKANES. VII. SOLVATION OF THORIUM NITRATE BY BIS-(DIALKYLPHOSPHINYL)-METHANES AND TRIALKYLPHOSPHINE OXIDES. J. R. Parker and C. V. Banks (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 631-40(Mar. 1965). (IS-899)

The complexes of thorium nitrate with bis(di-n-hexylphosphinyl)-methane (HDPM), bis-(di-2-ethylbutylphosphinyl)-methane (EBDPM), tri-n-octylphosphine oxide (TOPO), and tris-(2-ethylhexyl)-phosphine oxide (TEHPO) was studied. Partition, saturation, conductivity, and infrared data are presented on the nature of the complexes. In the presence of excess extractant, the species $Th(NO_3)_4 \cdot 2HDPM$, $Th(NO_3)_4 \cdot 2EBDPM$, $Th(NO_3)_4 \cdot 3TOPO$, and $Th(NO_3)_4 \cdot 3TEHPO$ predominate. At low ligand : metal ratios and when the metal is in excess other species exist. (auth)

24623 ION-EXCHANGE EQUIPMENT IN THE URANIUM INDUSTRY. Lajos Hasko. Magy. Kem. Lapja, 20: 76-82(Feb. 1965). (In Hungarian)

In the technology of the concentration of ore digestion liquors the uranium industry is doing pioneering work, especially as apparatus is concerned. Its aim is to develop continuous countercurrent extraction systems to supplant the fixed-bed columns for batch-wise operation used at the beginnings. First, research was directed towards the processing of solutions, then methods were found for sorption from sludges. This development work, from the first experiments to commercially exploited technologies, are discussed. The technologies mentioned will find, perhaps, suitable application in the hydrometallurgy of other metals as well. (auth)

24624 CONTINUOUS COUNTERCURRENT ION-EXCHANGE AND ITS CALCULATION METHODS USED IN THE URANIUM INDUSTRY. Mihaly Vigvari, Adam Balazs, and Sandor Dunay. Magy. Kem. Lapja, 20: 96-100(Feb. 1965). (In Hungarian)

After a survey of the ion-exchange extraction methods generally used in the production of uranium, a calculation method is given for the determination of the number of columns in an up-to-date continuous sorption procedure. Besides the data of the initial state (concentration of uranium in solution, quantity of liquid to be handled, etc.) the distribution isotherm and the work-line should be known. Since, in fact, the efficiency of the several steps in a column is always less than unity, in practice more than the calculated number of columns is needed. When the sorption kinetics for a given resin is known, the efficiency of columns can be calculated, and the number of columns necessary for an actual process can be given. The parameters for continuous elution can be given on the basis of the laboratory model experiments described. (auth)

24625 SORPTION OF CESIUM FROM DILUTE SOLUTIONS. B. L. Sawhney (Agricultural Experiment Station, New Haven). Soil Sci. Am. Proc., 29: 25-8(Jan.-Feb. 1965). (CONF-566-2)

Sorption of Cs by a synthetic cation-exchange resin and by several clay minerals, over a range of low Cs concentrations, was studied in the presence of different counterions. An ion-exchange equation was used to predict the sorption of Cs from dilute solutions. Exchange isotherms showed that the sorption of Cs by the resin followed these predictions: Exchange isotherms were straight lines with unit slope. Sorption of Cs by clay minerals, however, did not follow these predictions except when K^+ was the competing cation. When Ca^{2+} and Al^{3+} were the competing cations, the exchange isotherms for montmorillonite were straight lines with less than unit slope, showing that a larger proportion of Cs was sorbed with decreased Cs concentrations. The exchange isotherms of illite and vermiculite, on the other hand, had at least two distinct slopes suggesting that more than one type of exchange site is involved in the sorption of Cs by these minerals. These conclusions were also supported by estimates of the equilibrium constants calculated from Vanselow's equation. (auth)

24626 EXTRACTION OF LANTHANUM, CERIUM(III), PRASEODYMIUM AND NEODYMIUM BY TRIBUTYLPHOSPHATE IN THE PRESENCE OF PERCHLORATE IONS. A. M. Golub, M. I. Olevinskii, and E. F. Lutsenko. Ukr. Khim. Zh., 30: 1274-9(1964). (In Russian)

The extraction of La, Ce(III), Pr, and Nd from solutions of sodium perchlorate and chloride with tributylphosphate was studied. It was established that almost complete extractions of rare earth elements from aqueous solutions with concentrations 10^{-3} to 10^{-2} mol/l began at (ClO_4^-) = 1.6 to 2.0 g mol/l. At pH 1, complexes of the type [TBP] $[Me(ClO_4)_4 \cdot (TBP)_4]$ were extracted and at pH 3 $Me(ClO_4)_3 \cdot 4TBP$ complexes. The extraction equilibrium constants for the formation of $Me(ClO_4)_3$ and $Me(ClO_4)_4^-$ were calculated. (tr-auth)

24627 INVESTIGATION OF EXTRACTION OF THIOCYANATE COMPLEXES OF LANTHANUM, CERIUM, PRASEODYMIUM AND NEODYMIUM. A. M. Golub, M. I. Olevinskii, E. F. Lutsenko (Kiev State Univ.). Ukr. Khim. Zh., 31: 12-17(1965). (In Russian)

The extraction of La, Nd, Pm, and Ce(III) from solutions of sodium thiocyanate and chloride by the use of TBP was investigated. At pH 3 compounds with the composition $Ln(CNS)_3 \cdot 4TBP$ were extracted, at pH 1 compounds of the type (TBP) · H)$[Ln(CNS)_4(TBP)_4]$ were extracted. It was established that the rare earth elements were completely extracted with TBP from NaCNS solutions at concentration no lower than 0.6 mole/l and the calculated equilibrium constants for the formation of thiocyanide complexes of La, Ce, Pm, and Nd were very close to each other. The hypothesis and structure of the extracting complexes of the lanthanides is expressed, at pH 3, by $[Ln(CNS)_3(H_2O)(TBP)_4]$ or, at pH 1, by $[TBP \cdot H][Ln(CNS)_4 (TBP)_4]$. (tr-auth)

24628 ON SOLVENT EXTRACTION FROM ETHYLENEDIAMINETETRAACETATES (IRON AND THORIUM COMPLEXES). Yu. A. Zolotov, O. M. Petrukhin, and I. P. Alimarin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 20: 347-50 (1965). (In Russian)

It was found that iron(III) and thorium can be extracted from solutions containing sodium ethylenediaminetetraacetate in the presence of tetraphenylarsonium or diphenylguanidinium chlorides. The percentage was higher when mixtures of coordination-active solvents (alcohols) with highly polar ones (nitromethane, nitrobenzene) were used. A study was made of iron and thorium extraction depending on the concentration of substances. (auth)

24629 SOME BIS(DIALKYLPHOSPHINYL)METHANES AS SOLVENT EXTRACTANTS. James Roger Parker. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 202p.

An extensive review of some of the more important neutral organophosphorus compounds as solvent extractants is given. The compounds included are tri-n-butyl phosphate (TBP), tri-n-octylphosphine oxide (TOPO), tris-2-ethylhexyl)phosphine oxide (TEHPO), and bis(di-n-hexylphosphinyl)methane (HDPM). A review is also given on the effects of structure on the extracting power of neutral organophosphorus compounds. It was found that many phosphoryl containing compounds could be titrated as bases. By studying the extraction of nitric acid, a relative order of basicity was established for certain of the phosphine

oxides. TOPO was found to be more basic than TEHPO, and HDPM was found to be more basic than bis(di-2-ethylbutylphosphinyl)methane (EBDPM), which in turn was more basic than bis(di-2-ethylhexylphosphinyl)methane (EHDPM). The extraction of uranium(VI) nitrate, thorium nitrate, and samarium nitrate by TOPO, TEHPO, HDPM, EBDPM, and EHDPM was studied as a function of nitric acid concentration. Uranium(VI) nitrate and thorium nitrate can be quantitatively extracted by any of the reagents while samarium nitrate is extracted to a much lesser extent. The infrared spectra of the extractants were obtained. The phosphoryl band was a doublet in at least some of the spectra. The relative intensities of the two bands of the phosphoryl doublet were temperature-dependent. This gave evidence for the existence of rotational isomers for EBDPM, EHDPM, and TEHPO. No confirming evidence could be found in their proton magnetic resonance spectra. The structures of the complexes formed between thorium nitrate and TOPO, TEHPO, HDPM, and EBDPM were determined using saturation, equilibrium, infrared, and conductivity studies. Crystalline complexes of uranium(VI) nitrate and of thorium nitrate were prepared with EBDPM and with bis(dicyclohexylphosphinyl)methane (CHDPM) and their properties were studied. (A.G.W.)

24630 THE ELDORADO PROCESS FOR LIQUID ION EXCHANGE-IN-PULP OF URANIUM AND COPPER. E. G. Joe, G. M. Ritcey, and A. W. Ashbrook. 15p. (CONF-650203-5).

From National AIME Meeting, Chicago.

A process is described for the extraction of uranium and copper from sulfuric acid leach slurries employing liquid ion exchange in a pulse column. Significant quantities of uranium and copper together with cobalt and nickel occur in the residues from treatment of Port Radium gravity concentrates. These residues are primarily hydroxides and consequently are difficult to filter. The metal values are leached in sulfuric acid slurry at 20% solids at a controlled acidity to minimize solution of ferric ion. Uranium is extracted from the pulp with a mixture of tertiary amine and kerosene. Isodecanol is added as an emulsion suppressant. The loaded organic is stripped of uranium with sodium carbonate solution and the uranium is precipitated with caustic to form sodium diuranate. The pulp raffinate from uranium extraction is fed to the copper extraction pulse column. A mixture of di-2-ethylhexyl phosphoric acid and a substituted oxime in kerosene is used to effectively extract copper in the acidic pH range. The loaded extract can be stripped with sulfuric acid and/or EDTA. Some preliminary work is also presented showing the separation of cobalt from nickel in pulp slurry after uranium and copper are removed. (auth)

24631 IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF BERYLLIUM VALUES FROM BERYL-CONTAINING ORES. Saul Raymond Isaacs (to United Kingdom Atomic Energy Authority). British Patent 967,007. Aug. 19, 1964. Filed Mar. 7, 1962.

A process is reported for the recovery of Be from beryl-containing ores by leaching the sulfated ore with a mixture of ethanol and water. The ore is either fused and quenched or sintered prior to treatment with sulfuric acid. The leaching with ethanol-water mixture is carried out simultaneously or subsequently to the treatment of the ore with acid. A mixture of 70 to 95 wt % ethanol is used, but for best separation of Be from Al a 85 wt % solution is used. (B.L.M.)

24632 IMPROVEMENTS IN OR RELATING TO THE EXTRACTION OF MOLYBDENUM VALUES. Ivor Lloyd Jenkins and Arthur Gregory Wain (to United Kingdom Atomic Energy Authority). British Patent 967,823. Aug. 26, 1964. Filed Oct. 13, 1961.

A method is described for the extraction of Mo values from nitric acid solutions containing nuclear fission products by contacting the solution with a liquid organic phase that is substantially immiscible with the solution and that contains a hydrocarbon-substituted phosphoric acid having at least one hydroxyl group attached to the P atom. Such phosphoric acids include the mono-alkyl and mono-aryl phosphoric and phosphonic acids and the di-alkyl, di-aryl, and alkyl aryl phosphoric and phosphonic acids. Suitable organic diluents include kerosene, xylene, benzene, hexane, and dodecane. The extraction coefficient is greater than one for concentrations of Mo of 3 g/l and increases as the concentration of Mo decreases. The extraction coefficient is greater for Mo than for any of the other fission product metal values except Zr. The rate of extraction increases with temperature. Removal of the Mo values from the organic phase after extraction is achieved by contacting the organic phase with an aqueous solution containing fluoride ions. (B.L.M.)

24633 IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF URANIUM VALUES. Benjamin Frank Warner (United Kingdom Atomic Energy Authority). British Patent 968,037. Aug. 26, 1964. Filed Aug. 3, 1962.

A cyclic process is described for the recovery of U values from nitric acid solutions of irradiated U-containing fuel by the extraction of the U values with an organic solvent such as tributyl phosphate in kerosene. After extraction of the U along with any Pu that is present, most of the fission products remain in the nitric acid solution, and the solvent product is counter-currently washed with a dilute aqueous nitric acid solution. The washing solution is treated to remove entrained and dissolved organic solvent and is then used to dissolve further batches of irradiated U-containing fuels. This results in a reduction in the amount of highly active liquid that must be evaporated and stored. (B.L.M.)

24634 IMPROVEMENTS IN OR RELATING TO CHEMICAL EXTRACTION PROCESSES. John Kennedy, Roger Vincent Davies, and Brian Keith Robinson (to United Kingdom Atomic Energy Authority). British Patent 977,460. Dec. 9, 1964. Filed Sept. 4, 1957.

A process for the extraction of U from sea water consists of contacting the sea water with basic zinc carbonate supported on an inert carrier and eluting the U from the basic zinc carbonate with an aqueous solution of an alkali carbonate. The basic zinc carbonate has a composition intermediate between that of $ZnCO_3$ and $Zn(OH)_2$ and is precipitated directly onto an inert carrier preferably a fibrous material such as glass fiber or asbestos fiber in the form of a mass, net, or sheet. The basic zinc carbonate will extract U to the extent of about 500 μg per gram of zinc. (B.L.M.)

24635 IMPROVEMENTS IN OR RELATING TO RESIN EXCHANGE CELLS. Robert Spence, Anthony Cecil Fox, and Robert John William Streeton (to United Kingdom Atomic Energy Authority). British Patent 977,520. Dec. 9, 1964. Filed Feb. 17, 1956.

A resin exchange cell applicable to the extraction of substances from any dilute solution is particularly suitable for extraction of U from sea water. The active substance is in the form of a film applied to a backing structure having a large surface to volume ratio and constructed to allow a through-flow of liquid in turbulent contact with the surface. The backing structure may take a variety of forms, e.g., corrugated sheets and flat sheets stacked alternately, a plurality of open ended tubes, or a continuous strip wound in a spiral. (B.L.M.)

24636 IMPROVEMENTS RELATING TO NUCLEAR FUEL PROCESSING. Kenneth Hartley (to United Kingdom Atomic Energy Authority). British Patent 977,566. Dec. 9, 1964. Filed Mar. 8, 1962.

A method is provided for separating the ceramic component of reactor fuel elements from the non-fissile matrix in preparation for further stages of a recovery process. The bulk fuel material is heated by a reducing oxy-acetylene flame to a temperature higher than the melting point of the matrix. An upward flow of an inert gas at a cool temperature serves to rapidly cool the downward falling particles. A magnetic field acts to segregate ceramic particles from the magnetic matrix material. (B.L.M.)

24637 THORIUM RECOVERY. Robert S. Olson, Kernal G. Shaw, and Joseph P. Surls, Jr. (to Dow Chemical

Co.). U. S. Patent 3,153,568. Oct. 20, 1964. Filed June 8, 1960.

A process is described for the recovery of Th values from aqueous acidic solutions containing 0.01 to several hundred g/l of dissolved Th by extracting the Th with a water-immiscible mono- or dialkyl substituted ortho phosphoric acid. The acid is dissolved in an organic diluent and the alkyl group contains 2 to 20 C atoms. Any Fe present in the solution is reduced to the less extractable Fe(II) prior to extraction of the Th. The extraction may be batchwise or continuous operation. After extraction the Th laden organic layer is treated with an appropriate acidic solution (HF or H_2SO_4) to transfer the Th values into an insoluble salt that then is associated with the aqueous phase. The process is applicable to the recovery of Th from acidic sulfate byproduct solutions from U ore processing and from acidic nitrate and chloride solutions such as may result from the processing of ores and the pickling of metals. (B.L.M.)

24638 PURIFICATION OF EUROPIUM. Hugh J. Bronaugh (to Vitro Corp. of America). U. S. Patent 3,153,571. Oct. 20, 1964. Filed Apr. 18, 1960.

A method is reported for the separation of Eu from any soluble rare earth compound containing a minimum concentration of 11% Eu_2O_3. All the Eu is reduced to the divalent state with a one step reduction, and all the remaining operations are carried out in a non-oxidizing conditions. After reduction of Eu, the aqueous solution containing the soluble divalent europium ions and soluble tervalent rare earth ions is treated with sulfate ions to precipitate the europous sulfate crystals and a minor portion of the rare earths metal salts as impurities. After separation of the sulfate crystals, they are treated with a strong alkaline solution of a carbonate to form europous carbonate. The carbonate readily dissolves in acid, after which the rare earth impurities are selectively precipitated with a hydroxide at pH 8-9.5. After separation of the hydroxides, the solution containing Eu may be concentrated and treated to recover the Eu, eventually as Eu_2O_3. (B.L.M.)

24639 PROCESS FOR RECOVERING THORIUM AND RARE EARTH VALUES. Bernard J. Lerner (to Gulf Research and Development Co.). U. S. Patent 3,159,452. Dec. 1, 1964. Filed Feb. 19, 1960.

A highly economical and efficient means for separating Th and rare earth elements from ores and concentrates, particularly where they are associated with large amounts of lime, is reported. The ore in a finely divided state is mixed with water to form a slurry having a liquid to solid ratio of about 1:3 to 15:1. The slurry is treated with SO_2 gas until the slurry does not consume further SO_2. The leach liquor containing the soluble bisulfates of Th and the rare earths is separated from the spent ore solids by filtration or centrifugation. Treatment of the solution with sulfuric acid precipitates the calcium sulfate, and the Th and/or rare earth sulfates remain in solution to be separated by an appropriate method. (B.L.M.)

ENGINEERING

General

Refer also to abstracts 24903, 25071, and 25259.

24640 (BNWL-66) SAMPLING OF SOLID MATERIALS BY CORING TECHNIQUES. John R. Raymond (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 10, 1965. Contract AT(45-1)-1830. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Core sampling techniques are applicable for remote or undisturbed material sampling. Material core sampling methods, techniques, and equipment are described which have application in sampling radioactively contaminated materials. These methods include drive and rotary sampling. (D.L.C.)

24641 (GAMD-5239) PIZZA — AN IBM COMPUTER CODE FOR THE PLANE STRESS ANALYSIS OF TWO-DIMENSIONAL BODIES. Input Instructions. D. C. Cornell (General Atomic, San Diego, Calif.). Nov. 1, 1964. Contract AT(04-3)-167. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The PIZZA program is a numerical method for calculating the deformation and resulting stress distribution of two-dimensional bodies under plane stress conditions. The program is written in the FORTRAN IV language for the 7044 digital computer. Instructions for its use are given, and input and output are described. Execution times and optional capabilities are given, and example problems are solved. (D.L.C.)

24642 (NYO-3363-2) A THEORY FOR TURBULENT FLUID FILMS AND ITS APPLICATION TO BEARINGS. H. G. Elrod, Jr., C. W. Ng, and C. H. T. Pan (Mechanical Technology Inc., Latham, N. Y.). Mar. 1965. Contract AT(30-1)-3363. 73p. (MTI-65TR9). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

A new turbulent lubrication analysis was derived which takes into account certain well-established facts concerning turbulent shear flow. Consistent with lubrication-film theory, the nature of the local flow is taken to depend only on local film thickness, surface velocity, and pressure gradients. An eddy diffusivity treatment is used which incorporates the "law of wall" with the use of local (within the film) shear stress. Stress reversal phenomena are accommodated, and isotropy of the turbulent exchange mechanism in the plane of the film is assured. Coefficients are developed for use in the generalized Reynolds (lubrication) equation, and computation procedures for the static and dynamic characteristics of turbulent, self-acting bearings have been prepared. The non-linear effects due to the coupling of the shear-induced flows and the flows due to the circumferential and axial pressure gradients are fully considered in this analysis. Thus, it is anticipated that it, unlike the previous linearized analysis, is directly applicable also to turbulent, externally pressurized and hybrid bearings. (auth)

24643 (TRG-Report-270) A GAS BLENDER FOR MINOR COMPONENTS AT CONCENTRATIONS BETWEEN 10 AND 1000 v.p.m. D. G. Guthrie (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). July 20, 1962, Reprinted 1965. 9p. Dep.; $0.30(BIS), 1s. 9d. (HMSO).

An apparatus was designed for blending gas mixtures in which the required concentration of the minor component is in the range 10–1000 v.p.m. A measured quantity of the minor component is obtained by allowing the gas to pass through a calibrated leak for known time under specified pressure conditions. The gas emerging from the leak is collected in a previously evacuated volume, and is subsequently mixed with a known amount of the major component. The performance of the blender was assessed by making up mixtures of argon in helium and comparing the calculated concentrations with those obtained by mass spectrometric analysis. This mixture was chosen because at low concentrations, it is that which analyzed most accurately by mass spectrometry. At 50 v.p.m. of argon in helium the calculated and measured values agreed to within ±5%, and at 300–700 v.p.m. to within 2–3%. (auth)

24644 (TRG-Report-522) CAST EPOXY RESIN GAS BEARINGS. R. Swinhoe (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). May 21, 1963. 30p. Dep.; $0.80(BIS), 4s. (HMSO).

A casting technique is described which was developed as a means of producing plastic gas-bearing sleeves that do not require honing after removal from the mold. The bearing sleeves produced by this method had superior stop-start characteristics to those of the conventional metal type but their maximum operating temperature (~40°C) was lower. Some preliminary work, however, indicated that by modifying this casting technique it ought to be possible to produce a bearing sleeve that would operate at higher temperatures. The technique has possible applications in the field of high-speed rotating instruments. (auth)

24645 (UCRL-12271) DEVELOPING A PAYLOAD FOR A HIGH-ALTITUDE DIAGNOSTIC ROCKET — MECHANICAL ENGINEERING ASPECTS. Henry L. Knoll, Karl Kiraly, and John Harri (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 1, 1965. Contract W-7405-eng-48. 55p. Dep.; $3.00(cy), 2(mn) CFSTI.

The HAD (High Altitude Diagnostics) program was initiated for the development of a rocket payload capsule and recovery system that incorporated features found necessary during the previous high altitude test program associated with Dominic Operation. The desired payload capsule was to have an increased useful volume over the Dominic capsule and was to be designed for a high probability of recovery under adverse conditions. Within the limits of the HAD program, these objectives were met. (auth)

24646 (Y-1480) AN APPLICATION OF CRITICAL PATH SCHEDULING TO DESIGN ENGINEERING (SANS COMPUTER) (thesis). J. H. Boyd, Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 1, 1965. Contract W-7405-eng-26. 103p. Dep.; $4.00(cy), 3(mn) CFSTI.

A method is presented for the planning and scheduling of design engineering projects by applying the fundamentals of critical path scheduling, sans computer. An actual case history is used and the detailed mechanics of installing the project on critical path is presented. The case history is taken from the Plant Engineering Division of the Y-12 Plant. This method is suitable for design engineering organizations that range in size up to 200 engineers and draftsmen. The experience of two and one-half years of applying critical path scheduling to design engineering projects is summarized. (auth)

24647 CONTAMINATION OF SEALED SWITCHING DEVICES FOR SPECIAL WEAPONS. Paul Mahler (Picatinny Arsenal, Dover, N. J.). 21p. (CONF-620403-1)

From 10th National Conference on Electromagnetic Relays, Stillwater, Okla.

Data are presented showing that vapors of reactive metal are evolved during soldering or welding and that such vapors can contaminate contact surfaces. This contamination can explain the frequently observed erratic resistances of circuits, the contacts of which are known not to be organically contaminated. Two methods for preventing contamination of contact surfaces are outlined. (D.C.W.)

24648 NON-CLASSICAL SHELL PROBLEMS. Proceedings, Symposium, Warsaw, September 2-5, 1963. W. Olszak and A. Sawczuk, eds. International Association for Shell Structures. Amsterdam, North-Holland Publishing Company, and Warsaw, Polish Scientific Publishers, 1964. 1202p. (CONF-630909).

The nonclassical problems of shell analysis and design

are discussed, with attention given to thermoelasticity and shrinkage; linear and nonlinear viscoelasticity; plastic analysis and limit design; experimental research into the behavior of shell in presence of plasticity and conditions of creep; and design and structural problems arising when thermal, rheological, and plastic effects are taken into consideration. (L.B.S.)

Applications of Nuclear Explosions

24649 (PNE-302F) EMPLACEMENT AND FIRING OF HIGH-EXPLOSIVE CHARGES AND CRATER MEASUREMENTS. Final Report. A. D. Rooke, Jr., and L. K. Davis (Waterways Experiment Station, Vicksburg, Miss.). Feb. 1965. Project PRE-BUGGY. 128p. Dep.; $1.50(cy), 3(mn) CFSTI.

Six 1,000-pound high-explosive (HE) charges, each containing a capsule of radioactive tracer (lanthanum-140), were detonated at depths varying from 15.0 to 21.4 feet in desert alluvium to permit selection of the optimum depth of burst commensurate with crater size and shape and radioactivity release. Using the burst depth thus selected, four row shots, consisting of five 1,000-pound HE charges in each row, were fired with intercharge spacing varying from 1.0 to 1.5 apparent crater radii to determine the optimum spacing to produce a channel of satisfactory size and proportion and relatively free of irregularities. The immediate purpose of the experiment was to aid in the design of a proposed nuclear row-charge event (Project Buggy). Selection, fabrication, emplacement, and firing of the charges are discussed, along with the technique used to measure the apparent and true craters and zones of subsurface disturbance. The selected depth of burst was 19.8 feet, or a scaled depth of approximately 180 $ft/kt^{1/3.4}$. The optimum charge spacing was determined to be about one and one-eighth apparent crater radii. Comparison is made with results of previous row-charge experiments, and graphs of channel parameters are developed. Channel depth was found to be very sensitive to charge spacing, but channel width varied only slightly with spacing. It is concluded that a usable channel with suitable dimensions can be excavated by means of nuclear explosives. (auth)

24650 (SC-RR-65-6) CRATERS FROM FOUR EQUAL CHARGES IN A HORIZONTAL SQUARE ARRAY. Luke J. Vortman (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract AT(29-1)-789. 143p. Dep; $4.00(cy), 3(mn) CFSTI.

Craters were observed resulting from square arrays of 64-pound charges at various spacings and depths. The closest spacings yielded craters very like those from single 256-pound charges, while wider spacings yielded craters more or less square in shape and with a mound or pier at the center. Generally, the areas so uncovered were greater than for single 256-pound charges, except for very deep charges. Volumes, too, were enhanced by this configuration by as much as a factor of three. If the same factor is maintained for nuclear charges, the cost per unit volume of a crater from such an array will be within 20 percent of that for a single charge. (auth)

24651 NUCLEAR CRATERS FOR GROUND WATER RECHARGE. David K. Todd (Univ. of California, Berkeley). J. Am. Water Works Assoc., 57: 429-36(Apr. 1965). (UCRL-12060)

The availability of large craters constructed by nuclear explosives suggests that a valuable new technique can be supplied for designing artificial-recharge projects. The application and economics of this new construction method are discussed. Properties of nuclear craters and safety considerations are also included. (P.C.H.)

Facilities and Equipment

24652 (CNLM-5537) CONSTRUCTION COMPLETION REPORT—WELDING AND ANNEALING CHAMBER AND CLEAN ROOM—CANEL. G. L. Gould and C. R. Johnson (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Feb. 24, 1964. Contract AT(30-1)-2789. 39p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Descriptions are given of the CANEL welding-annealing facility for refractory metals, and of the clean room for the preparation, assembly, and storage of refractory metal components. Contract, cost, and performance data are given for both the facility and the room. (D.L.C.)

24653 (NYO-3237-1) DESIGN AND DEVELOPMENT OF A GAS-BEARING BRAYTON CYCLE TURBOCOMPRESSOR. (Mechanical Technology Inc., Latham, N. Y.). Mar. 1, 1965. Contract AT(30-1)-3237. 96p. (MTI-64TR7). Dep.(mn); $3.00(cy), 1(mn) CFSTI.

A technology program has been underway since June, 1962 to demonstrate feasibility of, and to identify problems areas associated with, the application of gas-lubricated bearings to closed-system gas-turbine machinery. A Brayton cycle gas generator (turbocompressor) utilizing self-acting gas bearings has been designed, built, and is now under test. Self-sustained closed-loop operation of the turbocompressor, using its own cycle gas as the bearing lubricant, was achieved on November 21, 1964. Design point conditions of the turbocompressor are: turbine inlet temperature = 1300°F, compressor inlet temperature = 100°F, compressor inlet pressure = 15.5 psia, turbocompressor speed = 24,000 rpm, cycle gas flow = ~6,700 lb/hr nitrogen, and simulated power output = ~30 kw. The aerodynamic, mechanical, and instrumentation aspects of the turbocompressor design and development program are described. A brief summary of the initial test performance is also presented. (auth)

24654 (NYO-3237-2) DESIGN, CONSTRUCTION AND CHECKOUT OF A HIGH-TEMPERATURE RESEARCH LOOP FACILITY. P. W. Curwen (Mechanical Technology Inc., Latham, N. Y.). Mar. 17, 1965. Contract AT(30-1)-3237. 114p. (MTI-65TR8). Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The High-Temperature Research Loop is an engineering facility which can be used for developmental testing of mechanical, electrical, and electro-mechanical components (or systems) which require high-temperature gas flow to simulate actual operating conditions. The facility constitutes a sealed, recirculating gas-flow system which can generate gas temperatures as high as 1600°F. Loop pressure may be varied from vacuum conditions to 500 psi. A wide variety of gases, such as argon, helium, neon, and nitrogen, can be used. The design and construction of the facility, preparation of instrumentation, and laboratory checkout of the first developmental component scheduled for testing in the loop are discussed in detail. The first developmental component to be tested is a gas-bearing Brayton cycle turbocompressor; the combination of loop and turbocompressor will comprise a closed, recirculating Brayton cycle system. (D.L.C.)

24655 (SC-TM-64-1791) CALIBRATION OF THE SANDIA LABORATORY 10,000 CURIE COBALT-60 GAMMA IRRADIATION FACILITY. Louis H. Sanders and Irving Auerbach (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The cobalt-60 gamma irradiation facility at Sandia Laboratory (Bldg. 803) was calibrated with the following dosimeters: ceric sulfate, cobalt glass, blue cellophane, nitrous oxide, and an ionization chamber. These dosimeters provided values which were in substantial agreement with the most carefully studied dosimeter, ceric sulfate. The latter dosimeter provided a value of $8.31 \pm .57 \times 10^6$ rads/hour on November 1, 1961. The cobalt glass dosimeter was used for mapping the source. (auth)

24656 RADIOGRAPHIC EFFECTS DUE TO THE WAVEFORMS OF X-RAY TUBE VOLTAGES AND CURRENTS. I. WAVEFORMS OF X-RAY TUBE VOLTAGES AND CURRENTS, kv-PEAK VALUES, AND ABNORMAL VOLTAGES. Hitoshi Kanamori (Shimadzu Seisakusho

Ltd., Kyoto). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 255-63(June 25, 1963). (In Japanese)

Waveforms of tube voltages and currents of single- and 3-phase rectified x-ray apparatus were measured by oscilloscope to investigate their distortion from simple sinusoidal. Peak-kv values were measured using a sphere-gap method. Radiographic performance of the x-ray beam was studied as a function of wave shape, kvp value, circuit, and rectification mode. (M.J.T.)

24657 SHIELDED ALPHA FACILITY (Engineering Materials). (Oak Ridge National Lab., Tenn.). 65 drawings. (CAPE-1171)

The facility described is used for handling alpha-emitting materials in the transuranium program. The 1-ft 6-in. thick shield of lead bricks encloses an area 10 ft 4 in. high, 10 ft wide, and 10 ft deep. At the side of the facility is a glove box 36 in. long, 30.5 in. high, with the top 17 in. deep, and the bottom 27 in. deep. Within the enclosure is a disposable glove box, which is constructed of structural steel. The plexiglas window is 60 in. wide, 64 in. high, and 54 in. deep. A remote bag-out mechanism provides a means for removing alpha contaminated materials from within the shielded α-tight enclosure. Materials to be removed are bagged and inserted into a magnetic container. The container is placed into the bag-out port and removed through the shield wall directly into a shielded waste cask. The lead filled, stainless steel cask is 17 in. OD and 8 in. ID. A sealing tool is used to quickly and efficiently seal polyethylene bags without spreading the bag out flat. The bag is gathered into a cylindrical shape and heat sealed using a standard soldering iron in which the tip has been replaced by a Cu blade with a knife edge. A plastic bag seal can be used to effectively and simply combine and separate individual α-tight enclosures without breaking the seal. (For details, see TID-4100) (M.C.G.)

24658 SEGMENTING CELLS FOR THE BSR/ELECTRICAL DRAWINGS/(Engineering Materials). (Oak Ridge National Lab., Tenn.). 12 drawings. (CAPE-1084)

Electrical drawings for the Bulk Shielding Reactor (BSR) segmenting cells are presented. The segmenting facility consists of a tunnel, discharging and charging rooms, change rooms, two small cells, and one large cell containing three windows. (For details, see TID-4100.) (D.C.W.)

24659 A CHAMBER FOR ELECTROSTATIC PRECIPITATION OF IONS OF DECAY PRODUCTS OF RADON. (to Tesla, Narodni Podnik). British Patent 967,293. Aug. 19, 1964. Priority date Oct. 31, 1960, Czechoslovakia.

A chamber made of electrically insulating material is provided for electrostatic precipitation of ions of decay products of radon on a negative collecting electrode. The outer periphery of the chamber is surrounded with electrically conductive screening rings each of which is connected to a respective tapping of a voltage divider. A planar positive electrode is situated at the bottom of the chamber with a planar plate negative collecting electrode situated opposite and parallel to the positive electrode. A radiation detector device to indicate the activity of the deposit is attached to the negative electrode. (B.L.M.)

24660 MASTER-SLAVE MANIPULATORS. Christopher Lawrence Paice (to Pye Ltd.). British Patent 976,851. Dec. 2, 1964. Filed Nov. 27, 1962.

A master-slave manipulator comprising a telescopic master portion, a supporting through tube, and a slave portion is designed for augmentation of the manual force applied to the handgrip to a slave tool by a power force. The manual force is applied to a flexible band constituting a mechanical link between the master hand grip and slave tool; and when the power source is actuated, it supplies power to a supplementary flexible band connected to the mechanical link. The power force is independent of the manually applied force and is a pneumatic force electrically controlled at the will of the operator. (B.L.M.)

24661 MECHANISM FOR EFFECTING STEP-BY-STEP MOVEMENTS OF A SUCCESSION OF ELEMENTS AROUND A CLOSED CIRCUIT. (to European Atomic Energy Community). British Patent 978,788. Dec. 23, 1964. Priority date Mar. 1, 1961, Belgium.

The mechanism for effecting step-by-step circulatory movements of a succession of elements around a closed circuit is particularly applicable to the circulation of elements in an inaccessible enclosure such as fissile rods, isotopes, and the like that are to be exposed to a neutron flux in a reactor. The circuit is made up of first and second elongated guide members alongside one another but not necessarily parallel and first and second transfer devices at opposite ends of the guide members. Each of the two transfer devices has two sockets that are alignable with the two guide members, respectively. A reciprocatory pusher is operable to push an object through one of the sockets into a guide member and then to withdraw. By the step-by-step rotary movement and the movement of the pusher, elements may be successively moved around the closed circuit. (B.L.M.)

24662 METHODS OF MANUFACTURING JOURNAL AND JOURNAL BEARING MEMBERS. Arthur John Bowhill (to United Kingdom Atomic Energy Authority). U. S. Patent 3,158,924. Dec. 1, 1964. Priority date May 17, 1961, Great Britain.

A method of manufacturing journal and journal bearing assemblies designed for operation with gas lubrication between the journal member and the bearing member is patented. The members are machined in such a manner that bearing surfaces of true circular cross section are formed on them. One member is radially stressed to deform its bearing surface; and after being machined and the stress being released, its bearing surface has a cross section with a number of lobes. The journal may also take the form of a hollow shaft that is internally stressed and externally machined to form an external bearing surface having a cross section with a number of lobes. (B.L.M.)

24663 RADIOACTIVE SOURCE MOVEMENT APPARATUS. Alexander E. Aikens, Jr. (to Budd Co.). U. S. Patent 3,159,748. Dec. 1, 1964. Filed Nov. 30, 1961.

An apparatus is described for moving a radioactive source from one position to another in a shielding environment having a minimum effect upon the shielding integrity. Linkage means are provided for bidirectional movement of a generally spherical source through a channel of circular cross section extending through a shielding material geometry. The linkage means consists of a series of generally spherically shaped contacting elements of shielding material extending in both directions from the source to the exterior of the geometry and having a radii substantially the same as that of the channel and the source. Means are provided for pushing the source forward and backward through the channel solely by the transfer of compressive forces. (B.L.M.)

24664 ARC POSITIONING SERVO. James L. Engle (to U. S. Atomic Energy Commission). U. S. Patent 3,173,983. Mar. 16, 1965.

The automatic control of the position of a light source, so as to maintain optical alignment of the source with an optical instrument such as a monochromator is described. An optical beam from a source of light, preferably an arc lamp, is directed through a monochromator. A beam splitter is introduced in the path of the beam beyond the monochromator to produce a subsidiary beam. A photoresponsive device such as a photocell is disposed in the subsidiary beam whereby the electrical output of the photocell is responsive to the intensity of the subsidiary beam which in turn is responsive to the intensity of the beam itself. The light source housing is then moved by a magnet in response to the electrical output from the photoresponsive device. (AEC)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstracts 24981 and 25710.

24665 (COO-1213-26) FABRICATION AND INSPECTION OF A 30-MEGAWATT STEAM GENERATOR PROTOTYPE FOR SODIUM COOLED REACTOR SYSTEMS.

(Baldwin-Lima-Hamilton Corp., Eddystone, Pa. Industrial Equipment Div.). Nov. 1, 1964. Contract AT(11-1)-1213. 165p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

The fabrication and inspection techniques used to build the 30-Mw prototype steam generator are outlined. The assembly and repair procedures are described, and drawings and photographs are included. Fabrication problems and solutions are described in detail. (D.L.C.)

24666 (GEAP-4843) TRANSITION BOILING HEAT TRANSFER PROGRAM. Quarterly Progress Report, January–March 1965. E. P. Quinn (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 15p. (EURAEC-1372). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Satisfactory operation of the stroboscopic lighting system has been obtained in photographic trial tests. Observational tests were started, using the new loop configuration. Measurements indicate a low two-phase flow disturbance level similar to that obtained with non-visual tests. High-speed motion pictures, now under examination, were obtained with steady lighting. Planning and organization of equipment for forthcoming heat transfer tests with induced flow oscillations have been completed. An adjustable solenoid valve will be used to vary the subcooled inlet flow, and a turbine-meter will be used to measure the flow variations. (auth)

24667 (LA-3211) HIGH THERMAL CONDUCTANCE DEVICES UTILIZING THE BOILING OF LITHIUM OR SILVER. J. E. Deverall and J. E. Kemme (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Oct. 1964. Contract W-7405-eng-36. 33p. Dep.; $2.00(cy), 1(mn) CFSTI.

The "Grover Heat Pipe" is a self-contained, thermal conductance device that has no moving parts, utilizes the heat being transferred for its operation, has a thermal conductance higher than any known material, and conducts heat with essentially no temperature difference. Heat is transferred by means of mass flow of a fluid, utilizing the latent heat of a two-phase system. For high-temperature applications, two liquid metals have been tested and found suitable as heat pipe fluids: lithium and silver. Lithium heat pipes have been successfully operated up to 1300°C with heat input fluxes of 200 watts/sq cm and silver heat pipes up to 2000°C with input fluxes of over 400 watts/sq cm. (auth)

24668 (LA-3246) THEORY OF HEAT PIPES. T. P. Cotter (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Feb. 23, 1965. Contract W-7405-eng-36. 34p. Dep.; $2.00(cy), 1(mn) CFSTI.

A heat pipe is a self-contained structure that achieves very high thermal conductance by means of two-phase fluid flow with capillary circulation. A quantitative engineering theory for the design and performance analysis of heat pipes is given. (auth)

24669 (LA-3264) RATH—THERMAL ANALYSIS PROGRAMS. R. F. Thomas, Jr., and M. D. J. MacRoberts (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1965. Contract W-7405-eng-36. 43p. Dep.; $2.00 (cy), 1(mn) CFSTI.

This report describes four computer codes for the computation of temperatures in solids of general geometry and the display of results. The codes permit temperature-dependent material properties; anisotropic conductivities; and convection, radiation, contact, and specified-flux boundary conditions. (auth)

24670 (NAA-SR-9827) FATIGUE CHARACTERISTICS OF 37-TUBE, MODULAR, STEAM GENERATOR HEAD. M. M. Lemcoe (Atomics International, Canoga Park, Calif.). Apr. 20, 1965. Contract AT-11-1-GEN-8. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

Pertinent results are presented of a series of fatigue tests relating to the evaporator and superheater 37-tube module heads for the sodium-heated steam generator described in NAA-SR-9826. Although the heads tested were fabricated from forged material different from the materials used in the prototypes, it is believed that the information compiled in this study still demonstrates the structural adequacy, with respect to fatigue, of the design and the parent materials used in the prototype steam generator heads. (auth)

24671 (NASA-TN-D-2280) EXPERIMENTAL LOCAL HEAT-TRANSFER AND AVERAGE FRICTION DATA FOR HYDROGEN AND HELIUM FLOWING IN A TUBE AT SURFACE TEMPERATURES UP TO 5600°R. Maynard F. Taylor (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1964. 32p.

A comparison of local heat-transfer coefficients for helium and hydrogen gases is made for several types of wall temperature distributions in order to determine whether data can be correlated by a Dittus-Boelter type equation. Wall temperature distributions for hydrogen are compared with one for helium with the result that any dissociation of hydrogen at the tube wall for surface temperatures up to 5200°R has less effect on the wall temperature than does the ratio of surface to bulk gas temperature. Range of conditions: local surface temperatures up to 5600°R, local Reynolds number from 7600 to 39,500, local ratios of surface to bulk gas temperature up to 5.6, and heat flux up to 1,700,000 Btu/(hr)(sq ft). (auth)

24672 (NASA-TN-D-2802) FEASIBILITY OF USING A THROTTLING CALORIMETER FOR LIQUID-METAL VAPOR QUALITY MEASUREMENTS. Ted W. Nyland (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1965. 16p. $1.00 (CFSTI).

The use of a throttling calorimeter for vapor-quality measurements in liquid-metal systems is discussed. The throttling calorimeter is limited to measurements in the quality range 0.91 to 1.00 for potassium based on stream temperatures between 1600 and 2200°F and expansion pressures from 1 to 10 pounds per square inch absolute. Pressure and temperature measurement errors introduce a maximum uncertainty of ±0.005 based on the assumption of the availability of accurate property values, while heat losses are estimated to produce uncertainties of less than ±0.005. The problem of sampling two-phase streams is discussed, and limits are placed on the degree of control required for the sampling system. These results are typical of those that would be expected for other liquid metals. (auth)

24673 (NP-14953) INVESTIGATION OF LIQUID METAL BOILING HEAT TRANSFER. Richard E. Balzhiser, Robert E. Barry, Bruce F. Caswell, Herman Merte, Jr., Andrew Padilla, Jr., and Lowell R. Smith (Michigan Univ., Ann Arbor. Liquid Metals Lab.). Feb. 1965. Contract AF33(657)-11548. 139p.

Critical heat flux determinations were completed for sodium and rubidium. Values fall above the predictions based on hydrodynamic considerations just as the earlier potassium results did. A modified design for the film boiling apparatus was completed which avoids the difficulties encountered with the use of condensing liquid metals as a heat source. Forced circulation studies were terminated after obtaining additional two phase flow data to repair the ruptured bellows in the test section. The difficulties in obtaining continuous flow since that time are discussed and conclusions reached regarding the use of zirconium as a hot trapping medium are cited. Recent cold filtering procedures, excluding the hot trap, provided encouraging results and prolonged operation is now projected for late February. Agravic results for mercury were obtained in the nucleate and film boiling regimes. Accelerations up to 15 times that of normal gravity were studied with definite effects on the heat transfer coefficient observed. (auth)

24674 (RFR-197) TRANSIENTS IN TWO-PHASE FLOW WITH ONE-DIMENSIONAL MODEL. S. Jahnberg (Aktiebolaget Atomenergi, Stockholm (Sweden)). Aug. 27, 1962. 27p. Dep.(mn).

A one-dimensional model for two-phase flow in an electrically heated channel is derived from the conservation

laws of mass, momentum, and energy. There are two versions of the model: (a) a constant driving pressure over the channel is assumed; (b) the channel is continued by a chimney and a downcomer to a natural circulation loop. The resulting system of partial differential equations is solved by a difference approximation which is coded for the Mercury computer. Version one of the model is tested against experiments performed by Quandt. In the tested cases the model predicted the power at the stability limit with an accuracy better than 10%. Tests of the second version against experiments on the Studsvik natural circulation loop are under way. (auth)

24675 (SC-RR-64-2141) DRAG COEFFICIENTS AND HEATING RATIOS FOR RIGHT CIRCULAR CYLINDERS IN FREE-MOLECULAR AND CONTINUUM FLOW FROM MACH 10 TO 30. Robert D. Klett (Sandia Corp., Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Methods are presented for calculating drag coefficients and average heating ratios for L/D ratios up to 20 and Mach numbers from 10 to 30. The cases of end-on, side-on, end-over-end tumbling, and random tumbling are covered for free-molecular and laminar continuum flow. (auth)

24676 (SU-247-7) TURBULENT HEAT AND MOMENTUM TRANSFER FOR GASES IN A CIRCULAR TUBE AT WALL-TO BULK TEMPERATURE RATIOS TO SEVEN. H. C. Perkins and P. Worsoe-Schmidt (Stanford Univ., Calif. Nuclear Technology Labs.). Sept. 1964. Contract AT(04-3)-247. 92p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

Measurements are reported for local friction and heat transfer coefficients with constant heat flux in an electrically heated circular tube. Precooled nitrogen in turbulent flow was used to obtain local wall to bulk temperature ratios from 1.24 to 7.54. The Inconel test section had a 40-diameter hydrodynamic entry section and a 160-diameter heated section. The bulk inlet Reynolds numbers covered the range from 18,300 to 279,000. Correlations in terms of both the bulk and the modified wall Reynolds numbers are presented for the local friction factors; the local heat transfer results are presented in terms of the wall to bulk temperature ratio with bulk properties and also directly on the modified wall Reynolds number. Both the friction and heat transfer results are shown to be significantly affected by the influence of the variable properties. Entrance region effects for both the heat transfer and friction coefficients are discussed. (auth)

24677 (WCAP-2056(Pt.IV.)) HIGH TEMPERATURE SUPERCIRTICAL PRESSURE WATER LOOP. PART IV. FORCED CONVECTION HEAT TRANSFER TO WATER AT NEAR-CRITICAL TEMPERATURES AND SUPER-CRITICAL PRESSURES. A. A. Bishop, R. O. Sandberg, and L. S. Tong (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Nov. 1964. Contract AT(30-1)-2948. 146p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Forced-convection heat transfer data were obtained at near-critical temperatures of 540 to 980°F and supercritical pressures of 3300 to 4000 psia for water flowing vertically upward in an annulus and cylindrical tubes. The data for cylindrical tubes were correlated with a 95% probability within a ±15% spread by the following dimensionless heat transfer correlation equation: $(hD_e/k)_b = 0.0069 (D_eG/\mu)_b^{0.90} (\bar{C}_p\mu/k)_b^{0.66} (\rho_w/\rho_b)^{0.43}(1 + 2.4/L_h/D_e)$, where $\bar{C}_p = (H_w - H_b/T_w - T_b)$. The heat transfer coefficients (h) for the annular geometry were generally higher than for the cylindrical tubes. Equal heat transfer coefficients were obtained when both walls of the annular space were heated equally. Near the pseudo-critical temperature, and at a heat flux greater than 0.85×10^6 Btu/hr-ft^2, sounds of the order of 1000 to 10,000 cps were recorded on tape and observed on an oscillograph. At a heat flux rate of approximately 1.0×10^6 Btu/hr-ft^2, wall temperature surges and flow oscillations, which had frequencies of approximately 0.01 cps, were observed where the outlet coolant temperature was near a pseudo-critical temperature and the inlet coolant temperature was substantially lower than a pseudo-critical temperature. Pressure drop data were obtained and were in reasonable agreement with the calculated values based on the average temperature in the test section. The following correlation was obtained for the friction factor: $\lambda = (0.335/(N_{Re})_b^{0.245}$, with a 95% probability of the data spread within ± 18%. (auth)

24678 A FORMULATION OF THE THEORY OF ISOTROPIC HYDROMAGNETIC TURBULENCE IN AN INCOMPRESSIBLE FLUID. Lawrence L. Lee (Univ. of Chicago). Ann. Phys. (N. Y.), 32: 292-321(Apr. 1965).

The theory of hydromagnetic isotropic turbulence in incompressible fluids is formulated using methods similar to those of quantum field theory. The present formulation is a generalization of Wyld's formulation of ordinary isotropic turbulence in incompressible fluids. Solutions for the velocity and magnetic field in the form of perturbation series are set up. Terms in the series are then represented by a one-to-one correspondence by diagrams similar to Feynman diagrams. A study of these diagrams reveals that they may be rearranged to give integral equations governing the second order correlation functions for the velocity and the magnetic field. These integral equations contain an infinite number of terms. To obtain manageable results, the equations are truncated at finite orders, yielding approximate equations. An approximation at the lowest order gives Chandrasekhar's equations, while a "second approximation" gives a more complicated set of equations. (auth)

24679 COMBINED NATURAL AND FORCED CONVECTION HYDROMAGNETIC FLOW BETWEEN ELECTRICALLY CONDUCTING WALLS. J. Srinivasan (Indian Inst. of Tech., Kharagpur, India). Appl. Sci. Res., Sect. B, 11: 361-81(1964-5)

The combined natural- and forced-convection flow of a viscous, electrically conducting liquid between parallel electrically conducting walls, in the presence of a transverse magnetic field is analyzed. The walls are taken to be at temperatures linearly varying along their lengths. The resulting nonlinear differential equations are solved in terms of even and odd functions depending on the Hartmann number and a modified Rayleigh number, so that solutions for a variety of conditions may be easily computed from their values. The cumulative effect of dissipative and Joule heating are found to be negligible. The Nusselt numbers and viscous drag are found to diminish with increase of the conductivities of the walls. (auth)

24680 LAMINAR SLIP FLOW OF AN ELECTRICALLY CONDUCTING INCOMPRESSIBLE RAREFIED GAS IN A CHANNEL WITH A TRANSVERSE MAGNETIC FIELD. R. M. Inman (Lewis Research Center, Cleveland). Appl. Sci. Res., Sect. B, 11: 391-400(1964-5)

The effects of a constant external magnetic field on the laminar, fully developed flow of an electrically conducting incompressible rarefied gas in a nonconducting parallel-plate channel are studied. Consideration is given to the slip-flow regime, in which a gas velocity discontinuity occurs at the channel walls. It is found that the magnitude of the slip velocity is unaffected by the magnetic-field strength for a given pressure drop, but that the mean gas velocity and wall friction coefficient are functions of both the velocity slip coefficient and the magnetic-field strength. The effect of a second-order slip-flow boundary condition is briefly discussed. (auth)

24681 ELECTROMAGNETIC PUMPS FOR ALKALI METALS. N. I. Marin, V. A. Povsten, T. V. Doktorova, and E. M. Avilova. At. Energ. (USSR), 18: 239-42(Mar. 1965). (In Russian)

Descriptions are given of a series of electromagnetic helical-rotor pumps with operating efficiency of 0.1 to 150 m^3/h and capable of pumping liquid metals at 650 to 773°C. (R.V.J.)

24682 EFFECTS OF PRESSURE ON THE HEAT EXCHANGE DURING BUBBLE BOILING OF LIQUID METALS. V. M. Borishanskii and K. A. Zhokhov. At. Energ. (USSR), 18: 294-6(Mar. 1965). (In Russian)

Correlations were made of experimental data on the heat transfer during bubble boiling of mercury, mercury-

magnesium amalgam, sodium, and water generalized for the pressure $p^*/p_{crit.} = 0.03$. The graphs plotted for the total region of relative pressure $p/p_{crit.}$ for metal liquids and water are in good agreement. At relative pressures of $(0.0001 \leq p/p_{crit.} \leq 0.1)$ the experimental points are distributed along a straight line (in logarithmic coordinates) with a 0.15 dip. The dispersion of the experimental points did not exceed ±30%. The data confirmed the existence of a certain common mechanism in bubble boiling of metal and non-metal liquids. (R.V.J.)

24683 TRANSFORMATION OF TURBULENT FLOW STRUCTURE OF MERCURY IN A TRANSVERSE MAGNETIC FIELD BEHIND SUDDEN EXPANSION. G. G. Branover, A. B. Tsinober, and E. V. Shcherbinin. Inzh.-Fiz. Zh., Akad. Nauk Belorussk., 8: No. 1, 114-15(1965).

The hydromagnetic flow of mercury expanding from a 0.2×10-cm slit into a 2×10-cm channel (120 cm long) was studied experimentally. A transverse magnetic field was applied along the channel length, and velocity profiles were measured with Pitot tubes. The flow was turbulent with $Re = 3.35 \times 10^3$. The magnetic field was found to flatten the velocity profiles noticeably and to reduce the size of the vortex zone in the vicinity of the expansion. (CFSTI)

24684 BURNOUT IN BOILING HEAT TRANSFER. W. R. Gambill. Nucl. Safety, 6: No. 2, 152-60(Winter 1964-65).

Developments concerning boiling burnout are reviewed. Studies on pool-boiling burnout, subcooled forced-convection burnout, bulk-boiling forced-convection burnout, and methods of improving the critical heat flux are described. (M.C.G.)

24685 HEAT-TRANSFER EXPERIMENTS OF SIGNIFICANCE TO REACTOR SAFETY. H. W. Hoffman and J. J. Keyes, Jr. Nucl. Safety, 6: No. 2, 171-9(Winter 1964-65).

Aspects of heat transfer related to nuclear safety are reviewed. Some examples of typical heat-transfer investigations are presented, with emphasis on the nature and scope of the problem studied, the approach employed in the investigation, the major results, and applications. Boiling and condensing, fog flow, spray cooling, transient boiling, cyclic thermal phenomena, and thermal-cycling experiments are discussed. (M.C.G.)

24686 HYDRODYNAMIC INSTABILITY IN BOILING-WATER REACTORS. V. V. Dolgov and O. A. Sudnitsyn. Teploenergetika, No. 3, 51-5(Mar. 1965). (In Russian)

Experiments were conducted in order to establish the conditions for hydrodynamic stability in a boiling-water uranium-graphite reactor. Two series of tests were made using a reactor fuel element assembly mockup consisting of four electrically heated, water-cooled tubes 6220 mm long with an inside diameter of 9 mm. In the first series of tests, at a given constant pressure, water flow rate and heat flux in the test section, the water inlet temperature was gradually increased (at ~ 4C intervals) until flow pulsation occurred. In the second series of tests, the use of throttle plates with an inside diameter of 2.65 to 5.00 mm for pulsation damping was investigated. The results show that other conditions being equal, reduction in heat flux, increase in pressure, and increase in mass velocity result in increased stability. At pressures of 1372×10^4, 1569×10^4, and 1765×10^4 n/m^2, flow pulsation occurred only at combinations of small velocities and high heat fluxes. The pulsations originated at a low (~1 to 3% by weight) steam content and a ratio of pressures $\Delta P_{water}/\Delta P_{steam\text{-}water}$ mixture of ~1.0 to 1.2. The use of a throttle plate with an inside diameter of 2.65 mm produced stable flows under all investigated conditions. The results are applicable to boiling water reactors with a core height of as much as 2 to 2.5 m. It is possible that reactors with higher cores will be subject to flow pulsations under other regimes. (CFSTI)

24687 AN IMPROVED METHOD OF GENERATING VAPOUR AND IMPROVEMENTS IN OR RELATING TO VAPOUR GENERATING PLANT. William Robert Wootton (to Babcock and Wilcox Ltd.). British Patent 966,971. Aug. 12, 1964. Filed Dec. 23, 1959.

A vapor generating plant is described that may be supplied with heat for superheating the vapor from a nuclear reactor particularly one having a liquid metal coolant. The initial stream of superheated vapor is generated under pressure through direct heat exchange between liquid and superheated vapor of the liquid. The stream of superheated vapor is supplied to a direct contact vapor generator to produce an augmented stream of saturated vapor. A further stream of saturated vapor is produced in at least one succeeding direct contact vapor generating stage by superheating the stream of saturated vapor from the preceding stage and supplying the superheated vapor to a direct contact vapor generator of the succeeding stage. (B.L.M.)

24688 IMPROVEMENTS IN VAPOUR GENERATORS. (to Babcock and Wilcox Co.). British Patent 966,995. Aug. 19, 1964. Priority date Mar. 28, 1960, United States.

An indirect heated shell-and-tube type vapor generator is described in which the heat is supplied by a hot vapor or vapor-liquid mixture flowing through the tubes within the shell. The generator has a horizontally elongated pressure vessel adapted to contain a vaporizable liquid having a liquid level at the junction of a lower liquid space and an upper vapor space. A U-shaped tube bundle is disposed horizontally with the legs of the tube bundle laterally spaced in the liquid space and extending along the major portion of the length of the pressure vessel and closely surrounded at its sides by baffle means. Below the liquid level a first U-shaped baffle is disposed adjacent to the outer periphery of the tube bundle, and a second U-shaped baffle is adjacent to the inner periphery of the tube bundle. The baffle means defines a pair of outer downflow spaces with an inner downflow space. The vapor generating chamber has a substantially uniform cross section throughout the length of the tube bundle. (B.L.M.)

Materials Testing

Refer also to abstracts 24829, 24835, 24845, and 24902.

24689 (HW-81780) AN IMPROVED EDDY-CURRENT TUBING TEST. H. L. Libby (General Electric Co., Richland, Wash. Hanford Atomic Products Operation. May 7, 1964. Contract AT(45-1)-1350. 31p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

An eddy current tubing test was developed that has new features to aid in the interpretation of the test coil output signals. Signal patterns for several different tubing test conditions are characteristically different and are readily identified. The major characteristics of the patterns are permanently recorded for future reference. Some of the signal analysis principles highlighted in a study on methods to obtain more information from the eddy current test were applied in the development of this test. The equipment was developed on an accelerated time schedule and improvements are still being made. The tester as described satisfied plant need and has since been successfully applied to several other tube test problems. (P.C.H.)

24690 RECENT RESEARCH DEVELOPMENTS AT POLAROID CORPORATION AND THEIR APPLICATION TO LOW ENERGY RADIOGRAPHY. Herbert J. Frede. 9p. (CONF-641017-8)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

The Polaroid Land Type 3000 X radiographic packet which employs a high-speed, panchromatized negative emulsion is described. When this film is exposed to x radiation in conjunction with a standard, blue-emitting fluorescent screen, it is capable of producing a positive reflection image of satisfactory density with only $\frac{1}{4}$ to $\frac{1}{16}$ of the radiation required for standard wet-process radiographic films. The panchromatic sensitization of these radiographic packets allows their use with intensifying screens having a variety of emission bands. The application of Polaroid photographic technology to flat film x-ray diffraction analysis so as to produce satisfactory forward

Laue, back reflection Laue, and precession patterns is discussed. Illustrations of results and pictures of the equipment are given. (M.C.G.)

24691 GAMMA RAY IMAGE CONVERTERS. Wilfrid F. Niklas (to The Rauland Corp.). U. S. Patent 3,163,765. Dec. 29, 1964. Filed June 14, 1961.

A gamma-ray image converter suitable for continuous or instantaneous inspection of dense materials is patented. A composite pick-up screen within an evacuated envelope includes an alkali-metal activated electron emissive layer and a heavy-metal target layer responsive to incident γ radiation for energizing the emissive layer to emit electrons. An inert coating on the target layer inhibits interaction between the alkali metal and the target layer. An electron-optical system, also within the envelope, utilizes the emitted electrons to produce a visible image. (A.G.W.)

Protective Structures

24692 (NP-15009) MOTION OF SUBSURFACE SOIL INCLUSIONS SUBJECTED TO SURFACE BLAST LOADING. L. W. Heller (Naval Civil Engineering Lab., Port Hueneme, Calif.). Apr. 1965. 62p. $3.00(CFSTI).

An experimental investigation was conducted to provide an insight into the fundamental motion characteristics of inclusions buried in a soil field and subjected to a blast loading applied to the surface of the soil. The purpose of the work was to provide knowledge of those factors influencing the failure of an underground protective complex composed of structures, utility lines, communication lines, appurtenances, etc. Dissimilar inclusions, representing elemental portions of a buried complex, were placed at different depths within a dry sand material compacted into a reinforced-concrete container. A sequence of 15 blast loadings at overpressure levels of 5 to 25 psi were applied to the surface of the sand, and the acceleration and displacement of the inclusions and the displacement of the soil were measured. The experimental results indicate that the inclusions do not move with the surrounding soil but displace into the soil in the direction of the propagating soil stress wave. Stiffer inclusions attained the greatest acceleration, velocity, and displacement; inclusion-soil differential displacements of up to one-third the maximum inclusion displacement were recorded. (auth)

24693 (ORNL-TM-1089) THE CAPABILITY, CREDIBILITY, AND DESIRABILITY OF BLAST SHELTER SYSTEMS: A SYSTEM FOR ANALYSIS. Sue Berryman Bobrow (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 22p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

This report distinguishes between grossly different types of blast shelter systems and the categories of variables relevant to their evaluation. It lists important variables (physical, physiological, psychological, cultural, economic, and political) for the categories, and where it is possible, scores alternative systems on each variable. (auth)

Space Propulsion

See also REACTOR TECHNOLOGY — Propulsion and Space.

Refer to abstract 25748.

Vacuum Engineering

Refer also to abstract 24476.

24694 HYDROGEN SORPTION-DESORPTION EFFECTS IN A HOT-CATHODE IONIZATION GAUGE. L. A. Petermann and F. A. Baker (Battelle Memorial Inst., Geneva). Brit. J. Appl. Phys., 16: 487-94(Apr. 1965).

Sorption-desorption effects arising at the molybdenum grid and thoriated iridium cathode of a commercially available ionization gauge are reported. Pumping speeds for hydrogen up to approximately 0.8 l sec^{-1} were found toward the extremes of the temperature range from ambient to 1000°C with a minimum $\leq$0.01 l sec^{-1} over 300 to 600°C and 350 to 850°C for grid and cathode, respectively. It is concluded that intermittent gauge operation has no advantage over continuous operation for chemically active gases. (auth)

24695 OPERATIONAL EXPERIENCE WITH ULTRA-HIGH VACUUM SPUTTER-ION PUMPED RESISTANCE FURNACES. J. S. Hetherington (Varian Associates, Palo Alto, Calif.). 11p. (CONF-603-10)

From Transaction of Meeting, Vacuum Metallurgy American Vacuum Society, New York, June-July 1964.

The design and performance of coldwall resistance furnaces using sputter-ion pumps and, in some cases, titanium sublimation pumping to achieve vacuum system base pressures below 1×10^{-10} torr and chamber pressures below 5×10^{-8} torr with the hot zone at temperatures above 1900°C, are described. Diagrams are included. (L.B.S.)

24696 OPERATIONAL EXPERIENCE WITH ULTRA-HIGH VACUUM SPUTTER-ION PUMPED RESISTANCE FURNACES. J. S. Hetherington (Varian Associates, Palo Alto, Calif.). 11p. (CONF-640903-12)

From American Vacuum Society Symposium, Chicago.

Equipment design, operating characteristics, and performance are reported for coldwall resistance furnaces using sputter-ion pumps or Ti sublimation pumping to achieve vacuum-system pressures below 10^{-10} torr and chamber pressures below 5×10^{-8} torr, for hot-zone temperatures above 1900°C. Some metallurgical applications of the furnaces are discussed. (M.J.T.)

24697 IMPROVEMENTS IN AND RELATING TO AN APPLIANCE FOR DEGASSING A TUBE UNDER PRESSURE. Georges Counas, Charles Eyraud, Michel Eudier, and Daniel Massignon (to Commissariat a l'Energie Atomique). British Patent 968,078. Aug. 26, 1964. Priority date Nov. 13, 1959, France.

A process and apparatus are patented for degassing a tube. The apparatus comprises (1) a fluid-tight enclosure containing a deformable element capable of being permeated by the gas, (2) means for compressing the element, (3) a recess inside the element adapted to contain the tube to be degassed, (4) a supporting member to withstand the compression, and (5) means for heating the degassed tube. Tubes degassed by the process are used particularly as fine filters for separating isotopes by diffusion of a gas. (B.L.M.)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 24422.

24698 (NYO-3008-1) OCEANOGRAPHIC OBSERVATIONS DURING OPERATION SWORDFISH. Final Report, Reference No. 64-45. Bostwick H. Ketchum, Nathaniel Corwin, and Paul B. Stimson (Woods Hole Oceanographic Institution, Mass.). Oct. 1964. Contract AT(30-1)-3008. 60p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Oceanographic observations were made in the test area prior to and after the underwater test. The following characteristics of the water column were studied: temperature, salinity, chlorophyll, dissolved oxygen, phosphorus, nitrogen, and silicate. The geostrophic currents were also measured. The chemical distributions after the test showed some slight variations which could not be attributed to the effects of the test. (D.L.C.)

24699 PECULIARITIES IN THE CONTENT OF RARE ELEMENTS IN SCHLIEREN GRANITE SEGREGATIONS. V. V. Lyakhovich (Inst. of Mineralogy, Geochemistry, and Crystal Chemistry of Rare Elements, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 351-4(Nov. 11, 1964). (In Russian)

A pegmatite granite was found to contain 7.84% biotite, 31.56% plagioclase, 34.59% anorthoclase, and 26.07% quartz. In biotite schlieren the plagioclase content falls to 7.0%, and the biotite content increases to 21%. Leucocratic schlieren are practically devoid of biotite (0.90%), while the quartz content rises to 46.0% and that of anorthoclase increases to a high value of 48.6%. Chemical analyses showed that the biotite schlieren are enriched in Mn, Fe, Mg, and Ti, and are depleted in Ca. There is a 30-fold enrichment of Nb, a 4-fold enrichment of Sc and Th, a 3-fold enrichment of Li, and a 2-fold enrichment of Sn and Zn in the biotite schlieren as compared to the content of element in the granite. The leucocritic schlieren showed a lower content of the above elements, but a higher content for Rb and Be because of the higher content of anorthoclase and quartz. Uranium concentrates in the most acidic leucocratic schlieren, but thorium concentrates in the most basic, dark-colored schlieren. The crystallographic properties of the minerals are important in determining the distribution of a number of rare metals in these minerals. (TTT)

Natural Radioactivity and Fallout

Refer also to abstract 24242.

24700 (CEA-R-2629) DÉTECTION DU TRITIUM ATMOSPHÉRIQUE PAR SCINTILLATION. EVOLUTION DE SA CONCENTRATION EN FRANCE. (Detection of Atmospheric Tritium by Scintillation. Variations in Its Concentration in France). Roland Bibron (Commissariat a l' Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1965. 104p. Dep.(mn).

Thesis submitted to Paris Univ. (France).

The tritium released into the atmosphere as a result of the explosion of thermonuclear devices is a useful radioactive tracer for the study of certain geophysical problems. The low concentrations found, however, call for the use of extremely sensitive detectors. Two detection methods using liquid scintillators are described. In the first method, the sample is introduced into the scintillator in liquid form, after prior concentration of the tritium by electrolysis. In the second method, the tritium is incorporated into the scintillator solvent molecule by chemical synthesis. The variations in the tritium concentration in rain water and of the free hydrogen in the air in France are examined. A discussion is then given of the seasonal variations in the case of rain water and these are compared to the variations in the strontium-90 concentrations. (auth)

24701 (CLOR-32) STRONTIUM-90 IN TAP WATER AND IN SOME RIVERS IN POLAND, 1962. R. Szepke and D. Grzybowska (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1964. 11p. Dep.

In 1962, the strontium-90 content in tap water in Warsaw City was estimated as 0.69 ± 0.08 pc/liter. In the fall of 1962, the concentration of strontium-90 in some rivers was 0.88 ± 0.15 pc/l. The data obtained are tabulated and plotted on diagrams. (auth)

24702 (LA-3245) BETA-GAMMA RADIOACTIVITY IN ENVIRONMENTAL AIR AT LOS ALAMOS, NEW MEXICO, FOR 1964. Jack W. Aeby and W. R. Kennedy (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1965. Contract W-7405-eng-36. 22p. Dep.; $2.00(cy), 1(mn) CFSTI.

The report is a continuation of work reported in the Los Alamos section of "Radioactive Fallout Data Collected from Eleven Atomic Energy Installations for 1958," LAMS-2397 (Nov., Dec. of 1958 and all of 1959), LAMS-2499 (for 1960), LAMS-2702 (for 1961), LAMS-2870 (for 1962), and LAMS-3071 (for 1963). The beta activities were not identified. However, since the measurements were made in the same manner, the values are relative to one another. The monthly average "per day" graphs show, in general, lower trends throughout this year than last. Fallout from the Chinese detonation, arriving late in October sent the averages for that month slightly higher than would have normally been expected. (auth)

24703 (NP-15013) RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM, 1963 RESULTS. (Ministry of Housing and Local Government, London (England); Secretary of State for Scotland, Edinburgh. Scottish Development Dept.; and Ministry of Health and Local Government, Belfast (Northern Ireland)). 1964. 24p. Dep.(mn); $0.30(BIS), 1s. 9d. (HMSO).

The ^{137}Cs and ^{90}Sr content was measured regularly during 1963 in public drinking waters of 29 locations in Great Britain. Data are tabulated. The average daily ingestion of ^{90}Sr and ^{137}Cs in drinking water was estimated as 0.83 and 0.31 picocuries per person respectively. These amounts are small compared with the average daily intake in the whole diet. (C.H.)

24704 THE HEALTH HAZARD OF RADIOACTIVITY IN FOODSTUFFS. A. Wolf (Charles Univ., Prague). Acta Univ. Carolinae Med., Suppl. 19, 169-71(1964). (In Czech)

The ^{90}Sr level in the average diet in Czechoslovakia was determined by using values for daily consumption of dietary products, as g/person and ^{90}Sr content in selected foods. Attempts were made to investigate what part nuclear reactors contributed to the contamination of foodstuffs. Even though it was possible to prove in one case an increase of the total β activity in the environment of a nuclear reactor up to a distance of 5 km in bees and honey (28 to 84%), it pointed out that nuclear reactors may endanger food chains by the atmosphere only in cases of accidents, which are not very frequent and are limited locally. The main source of food contamination by ^{90}Sr is fallout air polution. The ^{90}Sr content in the milk in Czechoslovakia was followed as to its dependence on air pollution from 1959 to 1962. Increased values were seen in the year 1959/1960, reaching 10 to 12 SU, followed by a temporary fall in 1961. At the end of 1961 values started again to increase and reached 23 SU in the autumn of 1962. The values obtained from calculation of the bone deposition in the adult population in 1962 was 3.2 SU. Considering a continuing increase of radioactivity, especially of ^{90}Sr, as has been so far found, the safety limit for health in adults would be reached in 230 yr. However, in children an untoward effect from increased radioactivity in foodstuffs would be manifested in 80 yr by an increased number of malformations in the newborn. (BBB)

24705 THE NUCLEAR RADIATION PROGRAM OF THE INTERNATIONAL GEOPHYSICAL YEAR. L. Machta (Weather Bureau, Washington, D. C.). Ann. Intern. Geophys. Yr., 32: 121-32(1964).

The IGY-IGC program for the worldwide measurement of nuclear radiation in air, in precipitation, and in the ocean is discussed. The IGY 80th meridian measurements submitted by the U.S. are discussed and interpreted by way of illustration of the scientific value derived from the program. Other tangible benefits gained from the IGY–IGC program are mentioned. A selected bibliography of reports with emphasis on interpretive articles, submitted to the World Meteorological Organization, is presented along with nine references. (L.B.S.)

24706 DISTRIBUTION OF ^{90}Sr OVER THE GROUND LAYER IN SOVIET UNION FROM 1959 TO 1960. V. I. Baranov, F. I. Pavlotskaya, G. A. Fedoseev, E. B. Tyuryukanova, P. M. Rodionova, E. V. Babicheva, P. N. Zatsetina, and T. A. Vostokova. At. Energ. (USSR), 18: 246-50(Mar. 1965). (In Russian)

Data are given on the distribution of ^{90}Sr in the Soviet Union during 1959–60. Observations indicated the tendency of ^{90}Sr to latitudinal distribution with the maximum concentration at 50 to 30° latitude. The mean content of ^{90}Sr in the upper layer of the soil (5 and 15 cm in depth) was 14.1 and 17.8 $\mu C/km^3$ respectively. The amount of ^{90}Sr in the soil did not increase during 1960. The migration of ^{90}Sr in soil layer depends mainly on the terrain and geochemical conditions. (R.V.J.)

24707 RADIOACTIVE FALLOUT AT THE PACIFIC OCEAN FAR EAST SHORE IN 1962–1963. E. I. Markichev, A. D. Shramichenko, A. S. Lapardina, V. V. Peretti, E. I. Vasil'kov, and V. V. Skornyakov. At. Energ. (USSR), 18: 300-1(Mar. 1965). (In Russian)

Radioactive fallout at four different points along the Pacific Ocean east shore was measured monthly during 1962–1963. A considerable increase of fission products was found during summer months of 1962, as compared to 1963. The increase was caused by nuclear explosions carried out Apr. 25 to Nov. 4, 1962. The mean specific activity of the rainwater in 1962 was 2 nC/l and 1 nC/l in 1963. The highest rainwater activity was observed Aug. 23, 1962. The mean maximum of fallout β radiation in Oct. 1962 and in Aug. 1963 was 1.0 and 1.4 Mev, respectively, which is in good agreement with published data. (R.V.J.)

24708 PALEOGEOGRAPHY AND RADIOACTIVITY IN THE LOWER KEUPER. W. J. Patzelt (Universitat, Erlangen, Ger.). Atompraxis, 11: 140-4(Mar. 1965). (In German)

During the Lower Keuper weathering minerals from adjacent denudation zones formed a sediment in a (rather) spacious basin. By examination of heavy minerals, color of quartz grains and cross-bedding, several sediment cones could be delineated in southern Germany. The sediments show a relatively low γ-activity. The sandstones of the apatite province in the basin are distinguished by an extreme constancy of radioactivity. In contrast, in the more peripheral garnet-apatite-zircon province the interference of several sediment cones is shown by varying activities and heavy-mineral spectra. Radioactivity is not confined to heavy minerals, but is mainly linked to the clay and silt fraction. Hydroxides, carbonates, and phosphates in the sandstone agglutinant are of minor importance as carriers of radioactivity. The gamma spectra demonstrates that mainly the $^{40}_{19}K$ and $^{238}_{92}U$ stages of radioactive disintegration cause the γ radiation. (auth)

24709 RADIOACTIVE CARBON-14 FROM NUCLEAR EXPLOSIONS. Reidar Nydal. Fra Fysik. Verden, 26: 51-4(1964). (In Norwegian)

Following the explosion of several large hydrogen bombs in the atmosphere, mostly over Novaja Zemlja, ^{14}C was detected at several points from Spitsbergen to Ethiopia. The measurements covered the residence time of radioactive CO_2 in the stratosphere and its mixing time in the troposphere. In August 1963, the radioactivity was doubled in the atmosphere of the northern hemisphere, with 80 to 85% of the added radioactivity assumed to be still in the stratosphere. Radioactivity in grain and milk approached a maximum each summer. The radioactivity in the human organism reached a maximum 1 to 2 years after the maximum activity in the troposphere. The radioactivity in the blood of a 24-year old person in Trondheim was 34.9 ± 1% above normal on Sept. 9, 1963. The same activity was measured in the troposphere 1.3 years earlier. (J.S.R.)

24710 IDENTIFICATION OF ALPHA-EMITTERS IN RADIOACTIVE FALLOUT. S. D. Chatterjee, S. K. Mondal, S. K. Das, and N. C. Ghosh. Indian J. Phys., 38: 635-8 (Dec. 1964).

The identity of alpha emitters in fallout material was investigated by their track lengths in nuclear emulsion plates. The starting material consisted mainly of rainborne dust particles which had been kept in hermetically sealed packets for about one year. (D.C.W.)

24711 RADIOACTIVITY OF THERMAL AND COLD SUBTERRANEAN WATERS IN THE VALLEY OF CHEPINO AND ITS IMMEDIATE ENVIRONS. E. Karamichailova, K. Nikolov, and K. Doichinova. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 9: 91-8(1962). (In Bulgarian)

The radioactivity (radon, radium, and thoron) was studied in 35 thermomineral springs in Velingrad (of which 6 were disclosed by drilling) and 8 were ordinary cold springs. Uranium was determined in 12 thermomineral and 2 ordinary springs. The radon content ranged from 5 to 20 emans, only a small number of springs having from 60 to 80 emans. The data, as far as they refer to samples studied previously, are in good agreement with the old values, which shows that their radioactivity does not change greatly. Among the new drillings, investigated for the first time, there was one with 189 (Korovo village). No correlations were established between the amount of radon in a water source and its debit, temperature, and depth. The radium, thoron, and uranium content of all the springs studied was below the maximum permissible concentrations from the point of view of health. (auth)

24712 SHORT-LIVED RADIOACTIVITY AS A RESULT OF THE FIRST CHINESE NUCLEAR WEAPON TEST. R. May and H. Schneider (Universitat, Gissen, Ger.). Z. Naturforsch., 20a: 166-7(Jan. 1965). (In German)

The analysis of a fallout sample showed that approximately 90% of the activity measured on Oct. 27, 1964, originated from the Chinese nuclear weapon test on Oct. 16. About 10% was produced by a short-lived mixture that is not to be expected in a normal fission product mixture and is probably from neutron-induced radioactivity. The fraction of older fission products was 11%. (tr-auth)

24713 METEOROLOGICAL PROBLEMS IN THE DISPERSION OF RADIOACTIVE MATERIALS IN THE ATMOSPHERE. W. Bleeker (Koninkjijk Nederlands Meteorologisch Instituut, De Bilt, [Netherlands]. p.32-56 of "Symposium Gezondheidsaspecten bij Radioactieve Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

The meteorological problems in the dispersion of radioactive materials in the atmosphere are discussed. The distinction between natural and artificial radioactive materials and the definitions, measurement methods, and units used are described. Tropospheric and stratospheric fallout is considered. The processes depositing radioactive materials in the troposphere and the atmosphere are reviewed. The effects of precipitation and storms on the distribution of radioactive materials are considered. The radioactivity resulting from nuclear reactors and other installations is indicated. (J.S.R.)

24714 NUCLEAR DETONATIONS AND MARINE RADIOACTIVITY. The Report of a Symposium Held at the Norwegian Defence Research Establishment, 16-20 Sept. 1963. S. H. Small, ed. Kjeller, Norway, Norwegian Defence Research Establishment, (1963). 221p. (CONF-630908)

Separate abstracts were prepared for the twenty papers presented. (C.H.)

For abstracts of individual papers see: 24256, 24257, 24258, 24715, 24716, 24717, 24718, 24719, 24720, 24721, 24722, 24723, 24724, 24725, 24809, 24810, 24811, 24812, 24813, and 25780.

24715 PHENOMENA OF UNDERWATER NUCLEAR EXPLOSIONS. E. A. Schuert (Naval Radiological Defense Lab., San Francisco). p.15-18 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

The general characteristics of an underwater nuclear explosion are described emphasizing the mechanisms by which the fission products and induced activity are released into the marine environment as a function of yield and charge depth. The explosion product history is followed throughout the dynamic event terminating in the definition of the residual pool of radioactivity in the surface layers. (auth)

24716 RADIOCHEMICAL AND PHYSICAL CHEMICAL CHARACTERISTICS OF NUCLEAR WEAPONS DEBRIS IN SEA WATER. N. E. Ballou (Naval Radiological Defense Lab., San Francisco). p.19-35 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Knowledge of radiochemical and physical chemical characteristics of debris from nuclear detonations in sea water is required for interpretations and predictions of radiation hazards, contamination, and decontamination characteristics, ecological effects, and transport properties of radioactive material resulting from such detonations. Following early theoretical predictions on nature of the debris from nuclear detonations in sea water a series of radiochemical and physical chemical studies has been carried out to establish experimentally such characteristics of the debris constituents as solubilities, oxidation states, particle size distributions, and radionuclide fractionation. Measurements have been made on material resulting from laboratory simulation of nuclear detonations in sea water and on material collected from actual detonations. Laboratory simulation experiments involved high temperature vaporization of fission product elements under water. Nuclear detonation studies included measurements on material from under water detonations in deep water and in shallow (lagoon) water. General agreement was observed between theoretical predictions and results from laboratory simulation experiments and from nuclear detonations. In addition, radiochemical studies of products of underwater nuclear detonations have revealed other important consequences of such detonations. Thus, radionuclide fractionation introduces large alterations in the composition and radiation characteristics of the base surge. Also, the partition of the debris among different regions (e.g., subsurface, surface, and base surge) can be deduced from radiochemical measurements. (auth)

24717 FALLOUT FROM NUCLEAR EXPLOSIONS ON THE WATER SURFACE. S. C. Rainey (Naval Radiological Defense Lab., San Francisco). p.37-49 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

A number of physicomathematical models have been developed and applied for the prediction of radioactive fallout from nuclear explosions on land-surfaces. The problem of predicting fallout from nuclear explosions on the surface of the sea or other bodies of water has, by contrast, received very little attention. Yet the problem is more complicated because land-surface fallout particles, once they are formed and incorporated in the fireball or rising cloud, can be considered invariant in their properties; water droplets can change continually by such processes as coalescence, evaporation, sublimation, condensation, freezing, and melting. Work has been underway to develop a preliminary fallout model for water burst. The NRDL Dynamic-Model, developed for predicting fallout from land-surface bursts, is taken as a point of departure. The essential features of this model are a description of both the rising phase of the fallout particles, when they are subjected to the forces of the cloud and stem dynamics, and of the free falling phase, when they are subjected primarily to the prevailing horizontal winds. Modifications to the model to account for salt water droplets as carriers of radioactivity naturally separate themselves into the rising and falling phases. The falling phase has been approached first. Evaporation-condensation equations have been combined with aerodynamic falling rate equations to determine the properties of a droplet having any initial sea salt concentration and falling from any initial altitude through any given atmosphere. A computer program has been prepared and sample results are available. To determine the initial conditions for the case of a nuclear explosion, the rising phase is being investigated. This study is divided into two parts: development and application of a theory for the rise of the radioactive cloud so that the history of the environment surrounding the drops can be specified; determination of the behavior or the drops within this environment up to the time that the phase of free fall commences. The current status of this work is described, and a comparison made of some predicted properties of fallout with those actually measured from a high yield water-surface explosion. (auth)

24718 THE EMPLOYMENT OF RADIOISOTOPES TO FOLLOW THE OCEANIC HISTORY OF UNDERWATER EXPLOSION PRODUCTS. W. J. Gurney, T. H. Shirasawa, and E. A. Schuert (Naval Radiological Defense Lab., San Francisco). p.51-9 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Methods and equipment used for simulating underwater nuclear explosions with conventional explosives and radioactive tracers are described and illustrated. Results are given for an experiment with Xe-133 tracer. (auth)

24719 METEOROLOGICAL PROBLEMS OF FORECASTING FALLOUT FROM NUCLEAR DETONATIONS IN SEA AREAS. P. B. Storeboe (Norwegian Defence Research Establishment, Kjeller). p.61-9 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

The problem of particle formation from sea water vapour is examined. Results from computations indicate that particles are formed which are much larger than those from an air-burst. These particles are mostly composed of common salt, and being highly hygroscopic they force the fallout forecaster to examine weather and humidity conditions very closely within and around the area for which he is concerned. A satisfactory fallout prediction probably requires more exact information about the detonation conditions than is necessary for a land-surface burst. (auth)

24720 EVALUATION OF RADIOACTIVITY IN THE MARINE ENVIRONMENT OF THE PACIFIC PROVING GROUND. L. R. Donaldson (Univ. of Washington, Seattle). p.73-83 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Radiobiological studies carried out in conjunction with weapon tests in the Pacific have contributed in a marked degree to a better understanding of the fate of radionuclides released under, on, and over the ocean. Investigations have been carried out locally at the Bikini-Eniwetok test sites and on a much more extensive scale by oceanographic surveys. The results are discussed to show the roles played by plankton, algae, invertebrates, and fish. (auth)

24721 SOME MEASUREMENTS OF FALLOUT CONTAMINATION IN THE MEDITERRANEAN SEA. A. A. Cigna, M. M. Ferraris, F. G. Giorcelli, and C. L. Papucci (Comitato Nazionale per l'Energie Nucleare, Rome). p.95-100 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Measurements of sea water activity in the Mediterranean Sea due to Sr-89, Sr-90, and Cs-137 for the period 1960 through 1963 are reported. Seasonal influences on Sr-90 contamination are discussed. Some results referring to sea organisms are also reported. Data are included on algae, fish, and invertebrates. During the period, Sr-90 showed an average five fold increase in sea water. (auth)

24722 STRONTIUM 90 IN SEA WATER AROUND DENMARK, THE FAROES AND GREENLAND, DURING 1962-1963. A. Aarkrog (Danish Atomic Energy Commission, Roskilde, Denmark). p.101-3 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Strontium-90 measurements on surface sea water collected around Denmark, the Faroes, and Greenland in 1962 and 63 are presented and the levels found are compared with the fallout levels. The increase in Sr-90 fallout in 1963 as compared with 1962 is evident in all sea water samples collected in 1963. (auth)

24723 ACANTHARIA AS "SCAVENGERS" FOR STRONTIUM AND THEIR ROLE IN THE SEDIMENTATION OF RADIOACTIVE DEBRIS. B. Schreiber (Universita, Parma, Italy). p.113-26 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Acantharia, a marine planktonic protozoa, are perhaps unique animals with respect to absolute and specific capacity to absorb Sr from the medium. This has been demonstrated by spectrographic and x ray investigations of the spiculae forming their skeletons, made of celestite monocrystals. It is assumed that also radioactive isotopes of Sr from fallout or wastes could be accumulated in the same ways. However, as cultures of Acantharia for turnover experiments of Sr have not yet been obtained, the author has planned a comparative research on the Concentration Factor(CF) for Sr-90 in plankton as a whole, choosing plankton samples rich and poor in Acantharia. This is the case for Thyrrenian and Adriatic plankton; the first with a mean amount of 10 to 20% of Acantharia, the latter with almost no Acantharia. A first attempt in this direction was made during 1961 and 62 and values of CF about 5 times greater were found for the Thyrrenian plankton where Acantharia are always present. A second and a third series of samples have been analyzed and although all the results are not as yet available, the above-mentioned conclusion seems to be confirmed. A study of core samples of coastal sediments along the Ligurian coast has been started comprising sedimentological and geochemical analyses of Sr/Ca ratio and measurements of radioactivity. (auth)

24724 RADIOACTIVITY IN FISH FROM THE BARENTS SEA. G. Berge (Inst. of Marine Research, Bergen, Norway). p.127-36 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Since October 1961 immature fish from the southern Barents Sea have been regularly monitored for radioactivity. Small contaminations have periodically been traced, and a slow increase in the total beta activity during the period seems evident. The following nuclides have been identified in the samples: Mn-54, Zn-65, Sr-90, Ru-106, and Cs-137. Cyclic variations in the potassium content and thereby the natural activity of cod and haddock have been observed, and are attributed to the starvation-reproduction cycles of fish. The fluctuations in fish contamination are discussed in relation to available fallout data and in relation to the environmental biological conditions. Increased levels in cod and haddock following the Russian bomb tests in 1961 and 1962 are attributed to increased fallout. Dominating increases in fish contamination during summer 1962 and 1963 are attributed mainly to increased feeding and to the state of the biological environment. The negative correlation which is observed between potassium content and radioactive contamination is presumed to indicate the importance of feeding as a contamination mechanism. (auth)

24725 THE MARINE ENVIRONMENT AND FISHERIES ALONG THE PACIFIC COAST OF CANADA WITH RESPECT TO POSSIBLE RADIOACTIVE CONTAMINATION FROM NUCLEAR DETONATIONS. M. Waldichuk (Fisheries Research Board of Canada, Nanaimo, British Columbia). p.163-6 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Hydrographic and biological features of the Canadian Pacific Coastline are described with a view to predicting the radiological effects of a nuclear detonation in the sea. In the particular case of a surface or underwater detonation in the Strait of Georgia, the pycnocline seal would be ruptured and fairly complete vertical mixing would follow. Most of the contaminated water in the surface layer could be replaced in about a month, but replacement of deep water below about 50 m might require perhaps a year or more. The commercial fishery most vulnerable to the effects of radioactive contamination would be salmon. (auth)

24726 DEPOSITION OF SOME RADIONUCLIDES ON TROPOSPHERIC AEROSOLS. Eliahu Shalmon. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 102p.

Aerosols were collected daily, near the surface of the earth, in two parallel systems. Each system consisted of two standard all-glass impingers in series, followed by a 2-inch-diameter membrane filter. The samples were counted for gross beta radioactivity 7 days after the end of collection. They were then combined and counted on a gamma spectrometer for the radionuclides: Ce-144 + Pr-144; Ru-106 + Rh-106; Cs-137; and Zr-95 + Nb-95. The analysis of the 121 sets of samples collected during the period of April 24 to September 26, 1963, indicated that about 70% of the gross beta radioactivity was associated with samples from the first impinger; 20% with the second impinger, and about 10% with filter samples. It was concluded that about 90% of the radioactivity of tropospheric aerosols derived from fallout is found on particles of diameters greater than about 0.7 micron. About 90% of stratospheric fallout particles undergo an interaction with tropospheric aerosols. The interaction appears to be a function of the surface areas and/or volumes of the aerosols, and also of their residence time in the troposphere. The commonly used fallout samplers provide a good assessment of the retention of fallout particles by man. The application of the International Commission on Radiological Protection lung model to determine fallout retention in the respiratory system, tends to underestimate the retention, but overestimates the inhalation hazard to man. The daily radioactivity of the samples of fallout collected during the sampling program indicates cycles several weeks long. (A.G.W.)

24727 DIFFERENTIAL ENERGY SPECTRA OF THE NUMBER FLUX AS A FUNCTION OF TIME AND ALTITUDE FROM FALLOUT FISSION PRODUCTS. T. W. De Vries (General Dynamics, Fort Worth, Tex.). 34p. (CONF-654-45)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The space-time-dependent gamma spectra due to fallout fission products were calculated. Analysis of these calculations shows that aerial monitoring of large fallout areas is practical. The design requirements of a monitoring dosimeter will vary with the phase-space to be monitored. The minimum design requirements would be realized if aerial monitoring is restricted to times after detonation greater than one day and altitudes of flight greater than 800 ft. (auth)

Techniques and Equipment

24728 (NP-14956) MULTIPLE ARRAY PROCESSOR. Quarterly Report No. 1, October 1-December 31, 1964. (Texas Instruments Inc., Dallas. Science Services Div.). Jan. 22, 1965. Contract AF33(657)-13904. 17p.

Engineering evaluation was carried out of components to be purchased for the processor. The delay lines used in the prototype system were examined carefully, and no performance degradation was observed. Identical delay lines have been ordered for the second system. The delay line equalizers have been designed, and the equalizer amplifiers have been selected and ordered. The timing system preliminary design has been completed and the circuitry has been set up on "breadboards." This circuitry is now undergoing temperature and reliability testing, and upon completion of the testing, the timing circuit printed circuit boards will be fabricated. The system enclosure modifi-

cations are being made at this time. Additional delay line shelves are being manufactured and the entire enclosure is being repainted. The card files for the delay line equalizer MCF programs and azimuthal processor have been ordered. (auth)

24729 (VESIAC-5218VU) DEPARTMENT OF DEFENSE TECHNICAL/OPERATIONAL PLAN FOR VELA UNIFORM PARTICIPATION IN PROJECT GNOME. Leo A. Kiley (Defense Atomic Support Agency, Albuquerque, N. Mex. Field Command). Nov. 1, 1961. 36p.

Though the principal Gnome experiments and the device to be detonated were not designed for any military purpose, Vela Uniform field experiments have been added to record the valuable data produced by the detonation without interfering in any way with Gnome experiments proper. In general, Vela Uniform is participating in Gnome to determine possible differences between signals and effects generated by a 5-kiloton nuclear detonation in bedded salt and those generated by other shots of different yield and media. Specifically, close-in motion data from Gnome will be used, along with seismic measurements out to 4000 km, to study the origin, development, and transmission of seismic signals; characteristics of electromagnetic and associated signals will be studied to determine their usefulness in detecting and identifying underground nuclear explosions; techniques of on-site inspection, including post-shot changes in shot-area characteristics, will be studied; and search will be made for other effects of possible usefulness in identifying underground nuclear tests. After a summarry of Gnome technical projects, the objectives and experimental procedures to be used in each of the Vela Uniform technical projects participating in the Gnome event are described. (auth)

24730 (VESIAC-5545VU) SYLLABUS OF ON-SITE INSPECTION. Second Edition. W. H. Westphal (Stanford Research Inst., Menlo Park, Calif.). July 1963. Contract AF49(638)-1225. 182p.

The objective, methods, and limitations of all observational and measurement techniques that may be applicable to the inspection of sites of unidentified seismic events are discussed. Emphasis is on the application of techniques in a surface land environment. The capabilities of all available on-site inspection techniques are technically evaluated. Also discussed is the application of inspection techniques in specific environments, including drill holes and mines, and for inspection of underwater explosions and underground explosions beneath a body of water. (auth)

24731 (VESIAC-7378VU) INTERPRETATION OF LRSM SEISMIC DATA. (Geotechnical Corp., Garland, Tex.). Revised Oct. 30, 1962. 18p. (TR-62-14)

Seismic data from the Long-Range Seismic Measurements (LRSM) field teams are compiled by The Geotechnical Corporation under Project VT/074. The forty LRSM teams operate identical seismograph systems consisting of long-period and short-period instrumentation. The long- and short-period systems each consist of one vertical and two horizontal seismographs. All instruments are amplified by phototube amplifiers and all data channels are recorded on both 35-millimeter film and magnetic tape. Basic information required to interpret the data from the LRSM seismograph systems is provided. (auth)

24732 (VESIAC-7542VU) STUDY OF SEISMIC PHENOMENA CONNECTED WITH EARTHQUAKES AND EXPLOSIONS. Final Report. Frank Press (California Inst. of Tech., Pasadena. Seismological Lab.). Feb. 1964. 19p.

Abstracts of technical reports prepared under Air Force contract are compiled. The reports are listed in seven categories which deal with different phases of the study of seismic phenomena connected with earthquakes and explosions. (auth)

24733 (VESIAC-8580VU) PART I. THE RADIATION OF ELASTIC WAVES FROM A SPHERICAL CAVITY IN A HALF SPACE. PART II. PRECISION DETERMINATION OF FOCAL DEPTHS AND EPICENTERS OF EARTHQUAKES. Armando Cisternas (California Inst. of Tech., Pasadena. Seismological Lab.). Aug. 1964. Contract AF49(638)-1337. 184p.

The dynamic response of an elastic half space to an explosion in a buried spherical cavity is investigated by two methods. The first is implicit, and the final expressions for the displacements at the free surface are given as a series of spherical wave functions whose coefficients are solutions of an infinite set of linear equations. The second method is based on Schwarz's technique to solve boundary value problems, and leads to an iterative solution, starting with the known expression for the point source in a half space as first term. The iterative series is transformed into a system of two integral equations, and into an equivalent set of linear equations. In this way, a dual interpretation of the physical phenomena is achieved. The systems are treated numerically and the Rayleigh wave part of the displacements is given in the frequency domain. Several comparisons with simpler cases are analyzed to show the effect of the cavity radius-depth ratio on the spectra of the displacements. A high-speed, large-capacity, hypocenter location program has been written for an IBM 7094 computer. Important modifications to the standard method of least squares have been incorporated in it. Among them is a new way to obtain the depth of shocks from the normal equations, and the computation of variable travel times for the local shocks in order to account automatically for crustal variations. The multiregional travel times, largely based upon the investigations of the United States Geological Survey, are confronted with actual traverses to test their validity. It is shown that several crustal phases provide control enough to obtain good solutions in depth for nuclear explosions, though not all the recording stations are in the region where crustal corrections are considered. The use of the European travel times, to locate the French nuclear explosion of May 1962 in the Sahara, proved to be more adequate than previous work. A simpler program, with manual crustal corrections, is used to process the Kern County series of aftershocks, and a clearer picture of tectonic mechanism of the White Wolf fault is obtained. Shocks in the California region are processed automatically and statistical frequency-depth and energy-depth curves are discussed in relation to the tectonics of the area. (auth)

24734 (VESIAC-8754VU) STUDY OF STATISTICAL DISCRIMINATION BETWEEN EARTHQUAKES AND EXPLOSIONS. Semiannual Technical Report No. 1. Harry Lake, George Hair, Ralph Guidroz, Dale Glover, Dan Borkowski, and Ronald Bauer (Texas Instruments Inc., Dallas). Oct. 28, 1964. Contract AF19(628)-4173. 77p.

The work discussed was undertaken as a feasibility study of discrimination between the seismic energy released by earthquakes and underground nuclear explosions. In this study, event recognition is based on parameters that can be detected at third-zone distances (greater than 1500 miles). Effort is being made to exploit the advances in seismic signal extraction offered by optimum processing of multichannel array data. (auth)

24735 ORE AND THE SOURCE OF ACID INTRUSIVES USING SULFUR ISOTOPES. W. H. Gross and H. G. Thode (Univ. of Toronto and McMaster Univ., Hamilton, Ont.). Econ. Geol., 60: 576-89(May 1965).

A review is given of four methods that might be used to determine the source of acid intrusive material. The method that involves the distribution of sulfur isotopic abundances is of interest to the economic geologist because sulfides commonly occur as primary minerals in both ores and associated intrusives. Sulfides associated with basic intrusives, believed on geological evidence to have originated in the sub-crust or mantle, have average $\delta^{34}S$ values similar to the meteoritic value of zero. Therefore, it might be assumed that sulfur in sulfides associated with acid intrusives have a mantle source if their $\delta^{34}S$ values are also close to zero. Unfortunately, under some conditions, volcanic, sedimentary, and biogenic sulfur can give zero $\delta^{34}S$ values. As a result $\delta^{34}S$ values close to zero for sulfur found in acid intrusive environments are of little

value in determining whether its source was in the mantle or from regenerated, upper-crust material. Acid intrusives and related mineral deposits formed by a regeneration of sedimentary and associated material of the upper crust might be distinguished if their sulfur has been fractionated by exogenetic processes so that the $\delta^{34}S$ values are materially different from zero. Some Archaean gold deposits, for example, were found to be associated with granites containing sulfur of this type. These so called hydrothermal-type gold ores may, in fact, have formed by the regeneration of ancient gold placers. It is unlikely that sulfur isotopes can be used to distinguish between productive and non-productive intrusives and no definite relationship was found between the $\delta^{34}S$ values of acid intrusive sulfur and the kind of associated ore mineralization. (P.C.H.)

24736 MEASUREMENT OF SAND-DRIFT ON THE SEA-BED BY A WATER-TIGHT G-M DETECTOR. Kentaro Minami (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 14: 83-8(Mar. 1965). (In Japanese)

An investigation of sand movement in the sea, using radioactive tracers, has been carried out widely in several parts of the Japanese coast since 1954. A G-M detector or scintillation detector, which is water-tight and sensitive to γ rays, was used in order to trace the radioactive glass-sands deposited at the definite point on the sea bed. By knowing the detection level, it was possible to estimate not only the necessary amount of the radioactive glass-sands to be deposited, but also the detectable limit on the area covered by the dispersing glass-sands on the sea-bed. A bundle of three G-M tubes was used in a normal run to trace the ^{60}Co labeled glass-sands in investigations at Niigata and Nakaminato harbors. In these measurements, when the background was 85 cpm for 10 minutes counting time, the net count, which was distinguished from the background with 95.4% reliability, was 22 counts for 1 minute. In this case, the minimum detectable amount determined experimentally was 2.5×10^{-6} $\mu C/cm^2$. (auth)

24737 EFFECT OF THE PRODUCT OF LOGGING SPEED AND THE TIME CONSTANT OF THE INTEGRATING CIRCUIT ($\nu \times \tau$) ON RADIOACTIVE WELL-LOGGING CURVES. Shih-ho Yung, Chi-ping Han, and Shao-chi Chu (Inst. of Petroleum, Peking). Ti Ch'iu Wu Li Hsueh Pao, 13: 305-23(Dec. 1964). (In Chinese)

In determining the thickness, depth of a rock layer, and also the true amplitude values of a radioactive logging curve directly from the measured curve, it is always necessary to correct for the error arising from the effect of the product of logging speed and the time constant of the integrating circuit $\nu \times \tau$. The existing method and principle of making such correction have serious defects. A method for examining the effect of $\nu \times \tau$, and to compute theoretically the radioactive logging curves by means of Fourier series are presented. Computations were done respectively for a point counter tube and a special type well-logging equipment commonly used in the petroleum industry. A set of curves was drawn and compared with the theoretical curves computed without taking into consideration of the effect of $\nu \times \tau$. Correction curves were then available. However, they still remain as theoretical results, not yet being tested experimentally or examined in practical radioactive well-logging work. (auth)

24738 URANIUM SERIES AGES OF CORAL FROM PACIFIC ATOLLS. David L. Thurber (Columbia Univ., New York), Wallace S. Broecker, Herbert A. Potratz, and Richard L. Blanchard. 17p. (CONF-498-8)

From Geological Society of America 1963 Annual Meeting, New York, Nov. 1963.

^{230}Th ages obtained on carefully selected coral samples from borings made in mid-Pacific atolls were evaluated. The quantitative relationships between the isotopes ^{238}U, ^{234}U, ^{230}Th, and ^{226}Ra as a function of age are given. The following criteria were developed for evaluating the results on samples of unknown age: the sample should contain less than a few percent calcite; the uranium concentration should be about 2 to 3 ppm; the age-corrected $^{234}U/^{238}U$ ratio should be 1.15 ± 0.03; the $^{226}Ra/^{230}Th$ ratio should be consistent with sample age; the $^{230}Th/^{232}Th$ ratio in the sample should be greater than 20; the $^{230}Th/^{234}U$ age for the sample should be consistent with its ^{14}C age; and the $^{230}Th/^{234}U$ ages should be consistent with stratigraphic data. Dates obtained by this method are listed and compared with those obtained by other methods. (M.C.G.)

24739 URANIUM SERIES DATING OF CORALS AND OOLITES FROM BAHAMAN AND FLORIDA KEY LIMESTONES. 9p. (CONF-498-9)

From Geological Society of America 1963 Annual Meeting, New York, Nov. 1963.

Data for the uranium series method of dating for corals in the Florida Keys are presented. The $^{234}U/^{238}U$ ratio was about that found in sea water. The ^{232}Th and ^{230}Th concentrations were low. Data from samples of fossil oolite and coral from the Florida Keys and the Bahamas are summarized. One sample of coral from the basement rock from the Berry Islands, Bahamas gave an age of 200,000 years. Another sample, from one of the terraces, gave an age of 80,000 years. Other dates obtained from the data are given. (M.C.G.)

24740 RADIOLOGICAL WELL LOGGING USING NEUTRON COLLIMATOR TO REDUCE THE EFFECT OF WELL FLUID ON THE LOG. Allen D. Garrison and Elmer Eisner (to Texaco Inc.). U. S. Patent 3,163,761. Dec. 29, 1964. Filed June 28, 1956.

A well logging device consists of an elongated instrument housing adapted to be raised and lowered through a well bore and including a radiation detector and a source of neutrons. The housing is generally enclosed by a neutron shield having a collimating aperture facing one side. Resilient means are provided for continuously urging the source toward the side of the well bore toward which the neutrons are directed; thus the neutrons directed into the formations traverse a minimum amount of well fluid. The neutron shield is arranged to thermalize fast neutrons from the source and to capture the thermalized neutrons to prevent their emission into the well fluid. (A.G.W.)

24741 RADIOACTIVITY BORE HOLE FLUID LOGGING. Fontaine C. Armistead (to Texaco Development Corp.). U. S. Patent 3,164,720. Jan. 5, 1965. Filed Apr. 2, 1962.

A method for measuring the size of a bore hole through an earth formation by radioactivity analysis is patented. Essentially, an apparatus for measuring either the neutron slowing down time or capture time or both is passed through the well bore, and the effect of the hole fluid upon slowing down or capture time is measured as an indication of the quantity of well fluid at the point of measurement. The size of the bore hole is a function of the quantity of fluid. A substance having a slowing down or capture time substantially different from that of formation may be added to the fluid in the bore hole prior to the measurement. The method may also be adapted to locate regions of fluid entry into the bore. (A.G.W.)

Thorium and Uranium Minerals

24742 RADIOACTIVE DISEQUILIBRIUM STUDIES IN SANDSTONE, POWDER RIVER BASIN, WYOMING, AND SLICK ROCK DISTRICT, COLORADO. J. N. Rosholt, M. Tatsumoto, and J. R. Dooley, Jr. (Geological Survey, Denver). Econ. Geol., 60: 477-84(May 1965).

Radiochemical analyses of ^{230}Th and ^{231}Pa were made by use of an alpha spectrometer on two suites of samples from roll ore bodies in the Powder River basin, Wyoming, and in the Burro No. 7 mine, San Miguel County, Colorado. The isotopic abundances thus determined were compared with those of the parent ^{234}U and ^{235}U isotopes previously determined by use of a mass spectrometer. In both ore bodies the amount of ^{230}Th and ^{231}Pa ranged from being in excess to being deficient of that required for radioactive equilibrium with ^{234}U and ^{235}U. The relationships between these daughters and the parent uranium isotopes indicate that uranium has migrated from the concave boundary

toward the convex boundary in both rolls. Very low $^{230}Th/^{231}Pa$ ratios in the ore from the Powder River basin roll indicate that ^{234}U has been preferentially leached from the ore for a period of at least 100,000 years rather than leached only during the last few thousand years. (auth)

24743 OKISLITEL'NO-VOSSTANOVITEL'NYE SVOISTVA OSADOCHNYKH URANONOSNYKH POROD. (Oxidation-Reduction Properties of Residual Uranium-Bearing Minerals). L. S. Evseeva and N. P. Fomina. Moscow, Atomizdat, 1965. 68p.

Geological and geochemical studies were made of the oxidation-reduction properties of uranium bearing minerals and their effects on U distribution and concentration in rocks. (R.V.J.)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection.

Refer also to abstracts 24424, 24473, 24842, 24843, and 25758.

24744 (AECL-2235) A CORRIDOR MONITOR FOR THE DETECTION OF $\beta\gamma$ CONTAMINATED PERSONS UNDER CONDITIONS OF VARYING γ BACKGROUND. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 13p. Dep.(mn); $0.50(AECL)

A monitor for the detection of β-γ contamination on persons moving along a corridor is described. The monitor has a sensitivity to β or γ contamination, which is proportional to the square root of the γ background. This provides the maximum sensitivity at all acceptable γ backgrounds compatible with a tolerable level of false trips caused by statistical fluctuations. A detailed circuit description and setting-up procedures are given in the appendix. (auth)

24745 (EUR-2210) RADIOACTIVE CONTAMINATION OF WORKERS. Proceedings of the International Symposium held in Munich (German Federal Republic) from 24 to 26 October 1962. (European Atomic Energy Community). Dec. 1964. 549p. (CONF-621002)

Sixteen papers are included; separate abstracts were prepared for each. The languages in which the papers were written or delivered and their English translations are included. (P.C.H.)

For abstracts of individual papers see: 24473, 24474, 24795, 24796, 24797, 24798, 24799, 24800, 24801, 24802, 24803, 24804, 24805, 24806, 24807, and 24808.

24746 (ORNL-P-1182) AN ANALYSIS OF FISSION PRODUCT DEPOSITION AND CORRELATION WITH EXPERIMENTS. M. N. Ozisik (North Carolina State of the Univ. of North Carolina, Raleigh) and F. H. Neill (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 23p. (CONF-650407-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Fission Product Release and Transport under Accident Conditions, Oak Ridge, Tenn.

Analytical relations are presented for deposition of radioactive particles from isothermal gas streams to the walls of a conduit as a function of time, distance, and variable source release rate. Effect of recirculation of the coolant gas on deposition was also included in the analysis. In the physical model considered, particles are assumed to be transported from the gas stream to the immediate vicinity of the walls of the conduit by diffusion; the resistance to mass transfer by diffusion was obtained by analogy from heat transfer coefficients. At the wall surface an imperfect retention scheme was assumed, that is, particles striking the wall surface are not all deposited but some re-enter the gas stream. This imperfect retention scheme is characterized by a wall surface resistance to mass transfer in series with the stream resistance to mass diffusion. To simplify the presentation of the analysis this unknown wall surface resistance was incorporated into a single factor, P, which enters the equations as a multiplier to the stream mass transfer coefficient. The analysis was correlated with experiments for deposition of fission products from isothermal helium streams on the surface of a stainless steel tube. (auth)

24747 (ORNL-TM-1049) REDISPERSION OF SETTLED PARTICULATES. B. R. Fish, R. L. Walker, G. W. Royster, Jr., and J. L. Thompson (Oak Ridge National Lab., Tenn.). Feb. 5, 1965. Contract W-7405-eng-26. 19p. (CONF-555-17). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

Surface contamination measurement techniques, were used in an investigation of particle resuspension in a room. A tracer dust was dispersed and allowed to settle in a room simulating a small workroom of average cleanliness. Contamination samples were collected by a person wearing coveralls and a respirator. The amount of tracer dust collected on the respirator filter was related to the amount that would have been inhaled without a respirator. Three redispersion runs using ZnS (3.1 μ MMD, σ_g = 1.9, ρ = 4.1 g/cm^3; fluorescence particle counting) for a total of 70 min with a respirator and one run using CuO (2.0 μ MMD, σ_g = 2.3, ρ = 6.45 g/cm^3; neutron activation analysis) for 90 min indicated that a person working in the room is likely to inhale one particle per hour for every 1,000 (vigorous activity) to 13,000 (light activity) particles per square meter of surface. The figure for moderate work activity is 3,000 particles per square meter. With CuO, it was found that, although an average vertical gradient did exist, the particle mass concentration varied by only a factor of 2 from ankle height to the breathing zone. (P.C.H.)

24748 (PG-Report-647) HEALTH AND SAFETY RESEARCH AT CHAPELCROSS. Annual Report, 1964. J. H. Martin (Production Group, United Kingdom Atomic Energy Atuhority, Annon (Scotland)). 1965. 8p. Dep.

Progress is reported in investigations of biological indicators of radiation injury with emphasis on radioinduced changes in thymine catabolism in rats and man. The metabolism of ^{85}Sr and ^{239}Pu in rats and the removal of ^{85}Sr by treatment with citrate and carrier Sr were studied. Data are included on investigations of the effects of waste disposal on radioactivity of the Solway Firth and Dounreay pond waters; neutron dosimetry, and the development of low level counting methods for use in environmental monitoring programs. (C.H.)

24749 (SC-RR-64-1651) LAUNCH ABORT ENVIRONMENT STUDY, AN INTERIM REPORT. F. D. Kite (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract [AT(29-1)-789]. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An interim review is presented of continuing work in launch abort environment studies. These studies define the environments of overpressure and high temperature. (auth)

24750 (UCRL-12339(Vol.I)) GAMMA DOSE RATES AND INTEGRATED DOSES FROM NEUTRON-INDUCED RESIDUAL RADIOACTIVITY IN SOIL. R. M. Lessler and F. W. Guy (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 1, 1965. Contract W-7405-eng-48. 52p. Dep.; $3.00(cy), 1(mn) CFSTI.

Gamma dose rates and integrated doses above the soil resulting from neutron activation of the soil by a nuclear explosion were calculated for various times after burst for several different initial neutron energies, heights of burst, soils, and atmospheric conditions. Methods of calculation are described and results presented. Examples are given of extrapolation of the results to situations not specifically covered in the data. (auth)

24751 (UCRL-12339(Vol.II)) GAMMA DOSE RATES AND INTEGRATED DOSES FROM NEUTRON-INDUCED RESIDUAL RADIOACTIVITY IN SOIL. R. M. Lessler and F. W. Guy (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 1, 1965. Contract W-7405-eng-48. 295p. Dep.; $6.00(cy), 9(mn) CFSTI.

Data tabulations (computer printouts) are presented for the following: soil constituents, neutron reactions, radioisotopes, half lives, neutron flux, total dose from time zero to 50 yr, and dose rate. The range of variables includes 5-cm to 3000-ft height of burst; 14-Mev to 5-kev neutrons; and wet and dry NTS, Dade, and Chester soil and lava clay soil. (D.L.C.)

24752 (UCRL-12388) EFFECTIVE HALF LIFE OF FALLOUT RADIONUCLIDES ON PLANTS WITH SPECIAL

EMPHASIS ON IODINE-131. Stanley E. Thompson (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 29, 1965. Contract W-7405-eng-48. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

The discrepancy between the observed mean reduction times for fallout radioisotopes deposited on plants and the radioactive half lives of the nuclides is due to a number of variables. The same variables operate regardless of isotope involved, and are related to the behavior of particles on plants. Physical and biological factors modify this behavior, accounting for the differences noted. The most probable effective half-life of any radioisotope on plants can be calculated by $T_3 = (13T_2/13 + T_2)$ where T_3 = effective half-life and T_2 = radiological half-life. Data on the effective half-life of ^{131}I on plants, based on recorded values of the half-life of ^{131}I on plants, are included. 42 references. (C.H.)

24753 DRUGS AND FOOD FOR THE DISASTER SHELTER. H. H. Mushlin (John Hancock Mutual Life Insurance Co., Boston). Am. J. Nursing, 64: 116-19(Oct. 1964).

After a description of the wounds and burns to be expected after a thermonuclear attack, the drugs and other medical supplies needed to adequately stock large fallout shelters are outlined. Practical aspects of use of radioprotectant drugs in exposed survivors are discussed. The most acute needs will probably be those connected with blast and radiation injury. A casualty rate of about 25% is to be expected. The actual amounts of materials to stock will depend on the size of the shelter and the capacity. Civilian defense authorities quote a figure of about 8.5 ft^3/person as necessary in such a shelter, but it is felt that about 10 ft^3 is a more adequate arrangement. Probably the greatest number of casualties will occur from the thermal effects of a bomb. Next in order would be wounds from flying debris such as contusions, lacerations, fractures, expected from any blast disaster. Then there would be the effects of radiation fallout. Experimental work on drugs to prevent radiation damage indicate that those showing the greatest promise are the sulfhydryl agents, of which the most protective has been AET (2-aminoethylisothiuronium). This drug used with cysteine is the treatment of choice to protect animals, especially monkeys, from radiation damage. With other drugs their effective therapeutic dose is so close to the toxic dose that they have been discarded; over 2000 chemical compounds have been experimented with, with varying degrees of success. Preparations that depress metabolism have some protective effect. Also, phenone drugs show some degree of radioprotection. Materials that produce tissue anoxia, such as respiratory and central nervous system depressants like morphine, ethyl alcohol, and reserpine, have a slight protective action. Hypothermia, by lowering general metabolic activity, may also produce a several-fold protective factor against radiation damage. However, it is not practical to produce this state in any large group of people simultaneously. Several lists of requisite medical supplies are provided. (BBB)

24754 A STATE RADIATION CONTROL PROGRAM 1959-1964. THE ANATOMY OF AN ALPHA-, BETA-, GAMMA-, AND X-RAY PROTECTION PROGRAM. Franklin D. Yoder and Clarence W. Klassen (Public Health Service, Springfield, Ill.). Arch. Environ. Health, 10: 796-800 (May 1965).

The basic structure and success of a radiation control program in the state of Illinois is discussed. The program includes not only nuclear facilities but also hospitals, doctors, and dentists. The program was brought about by cooperation between the Illinois State Department of Public Health and state legislators. Legislative authority is stressed as the skeleton or framework on which a total state radiation program is built. (P.C.H.)

24755 COMPARATIVE STUDY OF THE RATE OF MARITIME AND CONTINENTAL RADIOACTIVE FALLOUT. Roger Chesselet, Daniel Nordemann, and Claude Lalou (C.N.R.S., Gif-sur-Yvette, France and Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 260: 2875-8 (Mar. 8, 1965). (In French)

Quantitative analyses made by γ spectrometry made it possible to obtain the ratios between the rates of maritime (in the Atlantic and Mediterranean in the proximity of France) and continental (over France) radioactive fallout. These ratios were always higher than 1 and were comprised between 2 and 7. (tr-auth)

24756 AGRICULTURAL AND PUBLIC HEALTH ASPECTS OF RADIOACTIVE CONTAMINATION IN NORMAL AND EMERGENCY SITUATIONS. Papers Presented at the Seminar, Scheveningen, The Netherlands, 11-15 December 1961. Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 1-421(1964). Rome, Food and Agriculture Organization of the United Nations, 1964. (CONF-611202)

Separate abstracts have been prepared for 24 of the 26 papers included. The two papers not abstracted consider collaboration between public Health and other agencies in the U. S. and mutual international emergency assistance plans. (C.H.)

For abstracts of individual papers see: 24246, 24247, 24248, 24757, 24758, 24759, 24760, 24761, 24762, 24763, 24764, 24765, 24766, 24767, 24768, 24769, 24770, 24771, 24772, 24773, 24774, 24852, 25778, and 25779.

24757 SOURCES AND NATURE OF ENVIRONMENTAL RADIOACTIVE CONTAMINATION. W. T. L. Neal (Ministry of Housing and Local Government, London). Food Agri. Organ, U. N., FAO At. Energy Ser., No. 5, 19-34(1964).

The sources and nature of radioactive contamination of the environment are reviewed. It is pointed out that man has always been exposed to natural radiation from cosmic sources, naturally occurring radionuclides in the ground, and radionuclides present within the body. Radioactive fallout from nuclear weapons increases the levels of both external and internal radiation. The levels of environmental contamination from natural and artificial radioactivity are compared. The possible contribution to environmental radioactivity of local contamination due to reactor operation or radiochemical processing is considered. Both genetic and somatic effects of radiation on human populations are discussed. (C.H.)

24758 MECHANISMS OF RADIOACTIVE CONTAMINATION VIA AIR AND WATER. H. Jammet (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 37-42(1964).

Mechanisms involved in the radioactive contamination of man by air and water are reviewed. Topics discussed include the entry of contaminants into the body on these two vectors and the absorption, fixation, and elimination of radioactive contaminants introduced into the body through inhalation and drinking water. Sources of contamination of air and water and mechanisms for the direct and indirect transfer of radioactive contamination to man are reviewed. (C.H.)

24759 TRANSFER OF RADIONUCLIDES FROM THE ENVIRONMENT THROUGH AQUATIC FOOD PRODUCTS TO MAN. W. L. Templeton (Atomic Energy Research Establishment, Seascale, Cumb., Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 43-67(1964).

Problems involved in the radioactive contamination of the aquatic environment are discussed in terms of the transfer of radionuclides to man. It is pointed out that pollutants normally encountered in industrial waste and sewage are rapidly neutralized by chemical and biological processes in the aquatic environment while radioactive contaminants cannot be destroyed and reliance must be placed on dilution and dispersion and on radioactive decay. In order to have a base line upon which to measure the contribution and effects of artificially produced radionuclides in the aquatic environment the levels and kinds of naturally occurring radionuclides in the medium and in organisms must be determined. Data are presented on the contribution of fallout fission products and radioisotopes in reactor wastes to the radioactivity of seafoods in various areas. Results are included from laboratory and field studies on the metabolism of certain fission products by marine organisms. Emphasis is placed on the content of ^{137}Cs, ^{90}Sr, ^{89}Sr, ^{65}Zn, and ^{106}Ru in sea foods. Data on the

consumption of sea foods by several population groups are used to estimate the contribution to radionuclides from this source to the radiation exposure of man. (C.H.)

24760 ON THE RADIOACTIVE CONTAMINATION OF SOILS AND CROPS. A. C. Schuffelen (State Agricultural Univ., Wageningen, Netherlands). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 68-91(1964).

Fission products that reach the surface of the earth as fallout or as waste from reactors contain more than 30 radioactive nuclides, but only 3 of these are potential hazards. These are ^{90}Sr, a bone seeker with a long half life; ^{137}Cs that circulates in the body with a long half life; and ^{131}I that accumulates in the thyroid gland but has a relatively short half life. Iodine-131 is of particular interest in fresh fallout and in the case of reactor accidents while ^{137}Cs and ^{90}Sr are especially important in older fallout. The movement of these three radioisotopes from the soil, through soil, through plants, and to man is discussed. Emphasis is placed on the role of soil in the accumulation of fission products by fixation on soil particles. (C.H.)

24761 BIOLOGICAL BASES FOR STANDARDS AND MAXIMUM RADIATION LEVELS UNDER NORMAL CONDITIONS. E. E. Pochin (London Univ.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 137-48(1964).

Problems involved in the establishment of standards for maximum permissible radiation exposure are discussed. It is pointed out that it must be assumed that all radiation, in however small a dose, may occasionally have deleterious effects. The biological effects of low dose radiation are reviewed. Radiation risks are compared with other industrial risks for individuals and for the total population. (C.H.)

24762 MAXIMUM PERMISSIBLE LEVELS UNDER EMERGENCY CONDITIONS. E. E. Pochin (London Univ.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 149-59(1964).

Maximum permissible levels of radiation exposure for man under emergency conditions are discussed. Various suggested limits are presented. It is pointed out that permissible radiation limits will depend on the nature of the accident, control measures available, the number of people involved, the duration of the exposure, the probability of any repetition of the emergency, and other factors. (C.H.)

24763 ESTABLISHMENT AND APPLICATION OF ACCEPTABLE LEVELS OF RADIOACTIVE CONTAMINATION OF FOODSTUFFS. J. Spaander (National Inst. of Public Health, Utrecht). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 161-5(1964).

Problems encountered in establishing permissible levels for the radioactive contamination of foods are reviewed. Applications of these levels by public health and agricultural administrative services are discussed. Emphasis is placed on the contamination of foods by fission products from fallout and its effect on the total population. (C.H.)

24764 SOME CONSIDERATIONS IN THE ESTABLISHMENT AND APPLICATION OF GUIDANCE LEVELS OF RADIOACTIVITY IN FOOD. D. R. Chadwick (Public Health Service, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 166-72(1964).

Factors involved in the determination of permissible levels for the radioactive contamination of foods are reviewed. Criteria are presented for the determination of specific levels of radiation at which actions, such as the condemnation of certain food supplies, must be taken. (C.H.)

24765 OUTLINE FOR DISCUSSION ON THE DERIVATION OF MAXIMUM PERMISSIBLE CONCENTRATIONS FOR HUMAN DIET. R. Scott Russell (Agricultural Research Council, Wantage, Berks, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 173-88(1964).

The contribution of radioactivity in the human diet to the total radiation dose of tissues from all artificial sources is discussed. Maximum permissible radiation levels in individual components of the diet and in the total diet are presented, with emphasis on the content of ^{131}I and of ^{90}Sr. (C.H.)

24766 TYPES AND OBJECTIVES OF GENERAL AND LOCAL MONITORING PROGRAMS. AIR AND WATER. C. P. Straub (Public Health Service, Cincinnati). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 191-227 (1964).

Problems involved in monitoring of the atmosphere and surface waters for radioactivity are discussed. General principles for the design of air and water surveys at general and local levels are outlined. Procedures and equipment are described for sampling and radiochemical analysis of samples. (C.H.)

24767 DESIGN AND DEVELOPMENT OF MARINE MONITORING PROGRAMS. F. Morgan (Ministry of Agriculture and Fisheries, Lowestoft, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 239-44(1964).

Radioactive wastes can generally be disposed of at sea by conventional methods provided there is no return of the radioactivity to man. The paths by which the radioactivity is returned to man depend on the composition of the waste, the character of the water mass, the species of marine organisms present, and the habits of the human population concerned. These factors vary from site to site and a preliminary site survey must be carried out before any license for marine waste disposal is issued. Procedures are outlined for such site surveys and monitoring during the experimental period. (C.H.)

24768 UNITED STATES ATOMIC ENERGY COMMISSION EXPERIENCE FROM PAST INCIDENTS. C. L. Dunham (Atomic Energy Commission, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 247-59(1964).

Data are reviewed on a variety of radiation accidents that have occurred during the past 20 years within the United States Atomic Energy program. Details are presented on 3 AEC operational accidents which released radioactive material to the atmosphere. In only one was the public exposed in excess of ICRP recommendations. It is pointed out that within USAEC operations, including weapons test activities, the lost-time injury rates from all causes, including radiation injuries and deaths, are among the lowest in United States industry and about half those for the chemical industry during the same period. (C.H.)

24769 GENERAL ASSESSMENT OF POSSIBLE FISSION PRODUCT RELEASES FROM REACTOR ACCIDENTS AND THE ENSUING ENVIRONMENTAL HAZARDS. J. R. Beattie (United Kingdom Atomic Energy Authority, Lancashire, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 260-9(1964).

Reactor operations result in the generation of large quantities of fission products within the fuel elements and elaborate precautions are taken in the design and operation of nuclear reactors to prevent the escape of fission products. Data on the Windscale reactor accident and results from many experiments on the release of fission products from test specimens of irradiated fuel were used to estimate the nature of the release that would be likely to occur in the event of a reactor accident and to assess the consequences on public health. For most reactors the release would consist mainly of volatile fission products, the most important of which is ^{131}I. Analysis of a variety of fault conditions in gas cooled reactors indicated that about 100C of ^{131}I might be released over a period of a few hours. Detailed calculations showed that the ingestion hazard of greatest importance is that resulting from the contamination of milk by ^{131}I. Similar calculations were also carried out regarding possible contamination of milk with ^{137}Cs and ^{90}Sr. These calculations showed that the extent of milk restriction is likely to be determined by ^{131}I and would probably result in a temporary ban on milk from local supplies. (C.H.)

24770 MONITORING PROGRAMS IN EMERGENCY SITUATIONS. R. J. Garner (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 270-87(1964).

The primary aims of any emergency action must be to bring the emergency under control and to reduce to a

minimum injury to people and damage to property. In order that satisfactory preparations may be made to achieve these aims it is necessary to formulate a framework within which to work. Emergency planning for radiation accidents is discussed with emphasis on monitoring programs. (C.H.)

24771 REMEDIAL MEASURES FOR ENVIRONMENTAL RADIOACTIVE CONTAMINATION. R. F. Reitemeier (Atomic Energy Commission, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 299-309 (1964).

Radionuclides in the environment become internal radiation emitters within man through his intake of contaminated air, water, and food. Water, raw food materials, and foodstuffs may be given certain treatments that will reduce the content of one or more radionuclides. These measures include some practices that are normally followed in the production of wholesome foods or potable waters and also those that are applied for the sole purpose of reducing radiocontamination. Various methods are discussed. Topics discussed include water treatments, soil and crop management practices, land decontamination methods, livestock management, and remedial treatments for foods. (C.H.)

24772 LEGAL CONTROLS IN THE UNITED STATES TO PROTECT THE PUBLIC FROM EXPOSURE TO RADIOACTIVE MATERIALS. T. B. Conner, Jr. (Atomic Energy Commission, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 330-44(1964).

Atomic energy legislation in the United States is reviewed. The legal controls protect the public from exposure to radioactive materials. The role of the AEC in control over materials and facilities of the atomic energy industry is discussed. (C.H.)

24773 CO-OPERATION IN THE PREPARATION AND EVALUATION OF HEALTH AND SAFETY MEASURES FOR RADIOLOGICAL PROTECTION. J. G. P. M. Smeets (Ministry of Agriculture and Fisheries, The Hague). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 367-78 (1964).

Health and safety regulations of governments aimed at the protection of populations against the hazards of radioactive contamination and the use of nuclear energy are summarized. The need for national and international cooperation is stressed. (C.H.)

24774 UNITED STATES ATOMIC ENERGY COMMISSION RADIOLOGICAL ASSISTANCE PROGRAM AND ALLIED ACTIVITIES. F. R. Zintz (Atomic Energy Commission, Washington, D. C.). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 383-400(1964).

The activities of the USAEC in radiological assistance planning and operations are described and their relationship to similar activities at the national and international levels are discussed. (C.H.)

24775 RADIATION PROBLEMS. Charles E. Roessler (State Board of Health, Jacksonville, Fla.). J. Florida Med. Assoc., 51: 300(May 1964).

Measures taken by the Florida State Board of Health for controlling population radiation exposure are discussed. Included in the program are: consultations with users of x-ray machines to assist them in reducing exposure and surveillance of radioactivity in air, precipitation, milk, water, and other environmental materials. (H.G.D.)

24776 RADIOLOGICAL PROTECTION IN PEACETIME. PART I. C. O. Le C. Hughes. J. Roy. Nav. Med. Serv., 50: 159-61(1964).

Problems encountered in establishing and maintaining safety in nuclear installations are discussed. Duties of the health physicist are enumerated. (C.H.)

24777 CONTROL OF AIRBORNE RADIOACTIVITY IN ISOTOPE LABORATORIES. H. Abel and R. Stein (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 115-21(Feb. 1965). (In German)

The activity concentrations of radioactive aerosols in the air of isotope laboratories were determined. The method described can be applied for beta-emitting nuclides which are detectable by means of the filters of VEB Spezialpapierfabrik Niederschlag without any absorption correction. It is differentiated between routine control and control of special procedures. For routine control the counting rates corresponding to the maximum permissible concentrations were calculated upon the base of given collecting and measuring conditions. With the exception of ^{90}Sr these counting rates are significantly higher than the counting rates of radon and thoron daughter products on the filter. For long-lived radionuclides (e.g., ^{90}Sr) a technique of evaluating artificial radioactivity fraction on the filter is recommended. Provided that during control of special processes the sampling time is equal to the working-hours, the maximum permissible counting rates were calculated. Additionally, the maximum permissible concentrations for a single incorporation (accident) during one hour as well as the counting rates corresponding to these concentrations were determined. (auth)

24778 NUCLEAR SAFETY. Volume 6, Number 2. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Winter 1964-1965. $0.70(GPO) (domestic), $0.90(GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of technical Information, USAEC). 122p.

Developments in the field of nuclear safety are reviewed in 16 papers. Separate abstracts were prepared for 14. The two remaining papers were previously abstracted for NSA, see 18: 31782 and 37393. (M.C.G.)

For abstracts of individual papers see: 24684, 24685, 24779, 24780, 24781, 24782, 25068, 25636, 25643, 25644, 25645, 25694, 25753, and 25765.

24779 REVIEW OF 1964 GENEVA PAPERS RELATED TO NUCLEAR SAFETY. Nucl. Safety, 6: No. 2, 111-31(Winter 1964-54).

Brief discussions are presented of the subject areas with which relevant Geneva conference papers are concerned. An index to the papers covered is included. Topics covered include: general safety criteria, reactor siting and safety practices, transport of irradiated fuel, nuclear ship safety, aerospace safety, accident analysis, heat transfer and hydrodynamics, reactor kinetics, irradiation embrittlement of pressure-vessel steels, fuel-element performance, fission-product release and transport, control and safety system analyses, poison control, instrumentation, control-rod drives, reactor containment and safety features, radiochemical plant containment and safety features, management of solid and liquid radioactive waste, gaseous effluents and atmospheric movement, contamination of marine environment, human exposures and dosimetry, and reactor operating experience. (M.C.G.)

24780 ADMINISTRATION OF RADIATION SAFETY AT ARGONNE NATIONAL LABORATORY. John F. Ege, Jr. (Argonne National Lab.). Nucl. Safety, 6: No. 2, 132-42 (Winter 1964-65).

Argonne's site, personnel, and facilities are reviewed. The radiation safety program is described. Potential radiation levels, safety philosophy for operations, area monitoring, personal monitoring, accidental radiation releases, bioassay program, environmental monitoring, instruments, industrial hygiene, safety engineering, health physics at the CP-5 reactor, special surveys, waste disposal, and emergency planning are discussed. (M.C.G.)

24781 USE OF SPRAYS AS A SAFEGUARD IN REACTOR CONTAINMENT STRUCTURES. V. Griffiths (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Nucl. Safety, 6: No. 2, 186-94(Winter 1964-65).

A number of situations were examined to see whether water or other liquids from spraying equipment and foam injectors, which react with fission-product iodine, would quickly reduce the fission-product concentration in a containment atmosphere following an accident. Partition of iodine between the liquid and gas phases is discussed, along with the rate of transfer of molecular iodine to water drops. The solubility of iodine in alkaline solutions, transfer of molecular iodine to reactive solutions, removal of particles, and engineering considerations are also discussed. It was concluded that well-distributed liquid sprays could effectively remove molecular iodine from a containment

atmosphere following an accident. Calculations suggested that particles with absorbed iodine that are more than 1μ in diameter with a density of 10 g/cm³ should be rapidly removed by sprays. The submicron particles appeared to have extremely low or zero impaction efficiencies with water drops and it seemed likely that they would not be efficiently removed. (M,C,G.)

24782 RELEASE AND MONITORING OF ^{131}I AT NRTS, HANFORD, SAVANNAH RIVER, AND ORNL. K. E. Cowser (Oak Ridge National Lab., Tenn.). Nucl. Safety, 6: No. 2, 212-18(Winter 1964-65).

Studies were made of the release and monitoring of ^{131}I and the ultimate radiation exposure that man may receive. Installations used in the study were the National Reactor Testing Station (NRTS), Hanford Atomic Products Operation (HAPO), Savannah River Plant (SRP), and Oak Ridge National Laboratory (ORNL). Atmospheric release, terrestrial and surface-water release, environmental concentrations, estimated exposure of man, and empirical relations of ^{131}I in the environment are discussed. Data obtained on chemical and physical forms of radioiodine, monitoring for ^{131}I, deposition of ^{131}I, and intake by man are presented. (M,C,G.)

24783 AN APPRAISAL OF THE CURRENT FALL-OUT LEVELS AND THEIR BIOLOGICAL SIGNIFICANCE. R. E. Ellis (St. Bartholomew's Hospital, London). Phys. Med. Biol., 10: 153-76(Apr. 1965).

The existing levels of environmental contamination are reviewed, their trend with time is shown, and the range of levels in members of a particular community due to variations of age and diet, and to local meteorological conditions are considered. The methods of expressing the radiation dose to the population are discussed, and the levels suggested by various authorities when remedial action would be required are compared. The existing data on the interpretation of the risk to the individual from chronic radiation are also discussed. (P.C.H.)

24784 ABSORBED DOSE DETERMINATION FOR X-RAYS IN THE GRENZ-RAY REGION (5 TO 20 kev QUANTUM ENERGY). R. Loevinger and S. S. Yaniv (Stanford Univ., Calif.). Phys. Med. Biol., 10: 213-27(Apr. 1965).

Determination of the absorbed dose for very low-energy x rays is greatly simplified by the absence of scattered radiation. Absorber thickness can be scaled from one material to another by use of a relative effective density, which is the ratio of the mass energy absorption coefficients. Depth dose functions can be transferred from one material to another and from one FSD to another, and can be corrected for changes in air absorption. Exposure in roentgens can be measured directly with a suitable extrapolation chamber. The Fricke ferrous sulfate dosemeter is readily applicable, and a value of G = 14.8 was found for a 50 kvp unfiltered x-ray beam from a beryllium-window tube. It was concluded that the properties of very low-energy x-rays do not necessarily add to the uncertainties inherent in all x-ray absorbed-dose determinations. (auth)

24785 STUDIES ON SORPTION OF FALLOUT RADIOACTIVE SUBSTANCES ON TEXTILE MATERIALS. Jerzy Luczak and Zofia Pietrzak-Flis. Roczniki Panstwowego Zakladu Hig., 16: 17-26(1965). (In Polish)

Samples of textile and knitted materials made of natural and artificial fibers as well as of films made of soft vinyl polychloride, were subjected to the action of atmospheric factors, during winter, spring, summer and autumn. β radioactivity of the samples showed the sorption of fallout. The quantity of adsorbed radioactive dust depended upon the properties of tested materials, seasons of the year, and amounts of fallout. The adsorbed radioactive dust was permanently connected with textile, knitted material, and foiles, so that brushing and washing without detergent removed only partly adsorbed radioactive substances. The highest increase of radioactivity after exposure during the spring was detected on all kinds of materials tested. The following radioactivities in disintegration min^{-1} dcm^{-2} were detected: 12–14 thousands for textiles made of natural fibers, 5–6 thousands for textiles made of artificial fibers and vinyl chloride films, and 2–thousands for nylon knitted material. (auth)

24786 PROTECTION FROM IONIZING RADIATION—PUBLIC HEALTH ASPECTS. M. Weinbren. S. African Med. J., 37: 947-9(Sept. 14, 1963).

Problems of radiation protection unique to the population of South Africa are discussed in relation to recent recommendations of international advisory committees in this field. It is pointed out that one of the great responsibilities of the health authorities is the reduction of unnecessary radiation exposure as the result of diagnostic and therapeutic radiology. In South Africa this problem becomes more complicated because different racial groups are subjected to varying amounts of radiation, as far as the medical radiation sources are concerned. Fallout is not a problem in South Africa, because the nuclear bomb tests have been carried out in the Northern Hemisphere and radioactivity following these explosions does not cross the equator to the south. The organization of the services required to meet the public health responsibilities for radiation protection is discussed. (TCO)

24787 PROFILE OF LONG-LIVED RADIONUCLIDES IN MILK, 1923 TO 1936, 1946 TO 1961. G. K. Murthy and J. E. Campbell (Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio). May 1964. 9p. (Free, Public Health Service, Washington, D. C.).

The historical increase in the concentrations of strontium-90 and cesium-137 in samples of powdered milk produced during the years 1923 to 1936 and 1946 to 1961 is presented. No strontium-90 and cesium-137 activities were observed in samples produced prior to 1946, and any significant activity above background levels has been observed only since 1948. The rates of increase in strontium-90 and cesium-137 activities were similar while the rate of decrease of cesium-137, after the cessation of weapons tests in 1958, has been rapid compared with that of strontium-90. Comparison of the yearly strontium-90 in samples from Washington with those observed for powdered milk samples from Wisconsin and New York shows close agreement in spite of geographical differences and variations in feeding practices. The profile of strontium-90 in powdered milk was compared with that in liquid milk samples obtained by the Raw Milk Sampling Network of the Public Health Service. The possibility of using data from samples of milk produced prior to 1954 to compute human exposure to radioactivity is suggested. The yearly average rubidium-87 concentrations in milk showed very little change with time because of the similarity of its chemical and metabolic behavior to that of potassium. (auth)

24788 SONDERAUSSCHUSS RADIOAKTIVITAT. BUNDESREPUBLIK DEUTSCHLAND. DRITTER BERICHT BIS MAI 1963. (Special Committee on Radioactivity. Federal Republic of Germany. Third Report up to May 1963). Stuttgart, Georg Thieme Verlag, 1965. 135p.

Measurements of the radioactive contamination of air, water, soil, and food, as well as the body-burden of radioisotopes in the Federal Republic of Germany from 1955 through the fall of 1962 are presented. The data were evaluated and conclusions with regard to radiation effects on individuals, groups, and the total population are presented. Recommendations of the Special Committee on Radioactivity are outlined. (M.C.G.)

24789 SYMPOSIUM GEZONDHEIDSASPECTEN BIJ RADIOACTIEVE BESMETTING VAN LEVENSMIDDELEN GEHOUDEN TE 's-HERTOGENBOSCH OP 18 JULI 1962. (Health Aspects of Radioactive Contamination of Food. Symposium held at Bois-le-Duc on July 18, 1962). [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., 1962. 118p.

Separate abstracts were prepared for the six papers presented. (J.S.R.)

For abstracts of individual papers see: 24366, 24713, 24790, 24791, 24792, and 24793.

24790 RADIOACTIVE CONTAMINATION OF DRINKING WATER. F. J. W. van Haaren (Lab. Gem. Water-

leidingen, Amsterdam). p.57-74 of "Symposium Gezondheidsaspecten bij Radioactieve Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

The present situation with respect to the radioactive contamination of drinking water is described. The possible precautions to take in connection with radioactive contamination of water are reviewed. The relation between the contamination of drinking water and the contamination of food is considered. (J.S.R.)

24791 THE BEHAVIOR OF RADIONUCLIDES IN THE FOOD CHAIN. J. G. P. M. Smeets (Euratom, Brussels). p.75-97 of "Symposium Gezondheidsaspecten bij Radioactieve Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

The most important radioisotopes with respect to contamination of the food chain are summarized. The ways in which food is contaminated by fallout and the factors affecting food contamination are discussed. The interrelation of soil and vegetation is considered. Radioisotopes in animal products, with emphasis on ^{90}Sr, ^{131}I, and ^{137}Cs are discussed. (J.S.R.)

24792 RADIOACTIVITY OF FOODS; MEASUREMENTS AND PRECAUTIONS. J. W. Haken (Keuringsdienst van Waren, Amsterdam). p.98-110 of "Symposium Gezondheidsaspecten bij Radioactieve Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

The procedures used for the measurement of ^{89}Sr, ^{90}Sr, ^{131}I, and ^{137}Cs in foods are briefly described. The present state of the contamination of foods by fallout is summarized. Precautions that should be taken in the case of contamination or to prevent contamination are indicated. (J.S.R.)

24793 THE MEASUREMENT OF THE CONTAMINATION OF FOODS BY RADIOACTIVE MATERIALS. C. J. M. Raats (Philips Bedrijfsapparatuur Nederland N. V.). p.111-18 of "Symposium Gezondheidsaspecten bij Radioactieve Besmetting van Levensmiddelen." [The Hague], N. V. Uitgeverij W. P. van Stockum & Zn., [1962]. (In Dutch)

The principal methods used for monitoring and measuring the radioactive contamination of foods are briefly reviewed. (J.S.R.)

24794 CODE OF PRACTICE FOR THE PROTECTION OF PERSONS EXPOSED TO IONIZING RADIATIONS IN RESEARCH AND TEACHING. London, Her Majesty's Stationery Office, 1964. 70p. 4s. Gd. Net.

A code is presented for the guidance of persons working in research laboratories and universities using ionizing radiation. The code is based on recommendations of the International Commission on Radiological Protection. (C.H.)

24795 CONTAMINATION HAZARDS ARISING FROM REACTORS. G. C. Butler (Atomic Energy of Canada, Ltd., Chalk River, Ont.). p.121-30 of "EUR-2210."

Radioactive contamination hazards from reactor fuel, fission products, and activation products are discussed. Cases in which contamination could result and problems created by them are cited as examples. (P.C.H.)

24796 MAXIMUM PERMISSIBLE LEVELS OF SURFACE CONTAMINATION. H. J. Dunster (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). p.136-56 of "EUR-2210."

Contamination of inanimate surfaces and of the skin is discussed. Recommended maximum permissible levels of alpha and beta contamination for general areas and the skin are given. A simplified model for calculating the alpha radiation dose to the basal layer of the epidermis from radioactive material partially penetrating the skin is appended. (P.C.H.)

24797 INDIVIDUAL PROTECTION. W. N. Saxby (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.337-53 of "EUR-2210."

Methods for the protection of the individual against the hazards arising from radioactive materials are discussed. These methods involve equipment, planning, clothing, and health physics monitoring. (P.C.H.)

24798 CONTAMINATION CONTROL FOR REACTOR ACCIDENTS. J. M. White (Atomic Energy of Canada, Ltd., Chalk River, Ont.) and G. C. Butler. p.443-64 of "EUR-2210."

Two serious reactor contamination accidents at Chalk River are discussed, along with the lessons learned and the pre-planning for accidents that has been done as a result of the experience. The accidents involved contamination from the NRX and NRU reactors. Proper equipment and trained men are stressed in the event of an accident. (P.C.H.)

24799 CONTAMINATION HAZARDS IN CHEMICAL AND METALLURGICAL INDUSTRIES. F. Wachsmann (Universitat, Erlangen, Ger.). p.503-14 of "EUR-2210." (In English and German)

The uses of radioactive materials in chemical and metallurgical industries and their hazards are discussed. The uses include: monitoring of production processes by labeling manufactured articles; monitoring conditions in production plants and their operation; processing desirable or undesirable radioactive materials; and the use of radioactive emitters for irradiating manufactured articles or machinery in order to determine their characteristics or quality. (P.C.H.)

24800 RADIOACTIVE CONTAMINATION OF WORKERS IN URANIUM MINES. J. Pradel (French Atomic Energy Commission, Fontenay-aux-Roses, France). p.515-52 of "EUR-2210." (In English and French)

In uranium mines, the hazards of contamination by inhalation are of two kinds: those due to the radon release when the rock is broken or which diffuse through the fissures in the soil; those due to the dust put into suspension in the air during operations. Monitoring methods and equipment and protective devices for uranium mining are discussed. In France, changes in operating methods, strict discipline in the workings, the introduction of systematic monitoring, and awareness of responsibilities have resulted in safety conditions for uranium mining far superior to those in many older industries. Maximum permissible levels for miners are also discussed. (P.C.H.)

24801 CONTAMINATION HAZARDS IN LABORATORIES USING ISOTOPES. Suzanne Simon (Bordet Inst., Brussels) and R. Constant. p.553-70 of "EUR-2210." (In English and French)

Radiation hazards from the use of radioisotopes in biological laboratories and in the medical services are discussed. Methods used for the prevention of hazards caused by patients themselves are described. It was concluded that the greatest hazard in medicine and biology is the amateur who underestimates the need for caution. (P.C.H.)

24802 INTERNAL CONTAMINATION STANDARDS. H. Jammet (French Atomic Energy Commission, Fontenay-aux-Roses, France). p.591-611 of "EUR-2210." (In English and French)

The actual establishment of internal contamination standards and their practical application are discussed. The normal procedure for the maximum permissible doses fixed very generally for all types of irradiation for deriving the maximum permissible concentrations and also the obstacles to be overcome in the field of either dosimetry, mathematical models, or the biological factors to be chosen are described. (P.C.H.)

24803 MEASUREMENT OF EXTERNAL CONTAMINATION. M. Oberhofer (Technical Univ., Munich). p.617-32 of "EUR-2210." (In English and German)

Two methods of monitoring surfaces for radioactive contamination, direct measurement and the wiping test, are discussed. Equipment and techniques for both methods are described. (P.C.H.)

24804 INTERPRETATION OF THE RESULTS OF MEASUREMENTS EVALUATION OF THE TISSUE DOSES AND RECORDING IN INDIVIDUAL MEDICAL DOCUMENTS. C. Polvani (Italian National Nuclear Energy Committee, Rome). p.669-703 of "EUR-2210." (In English and Italian)

In the present state of knowledge and without disrupting the organizational set-up of the usual radiological protection services (physical and medical), the possibility of evaluating and recording individual doses is illustrated. A practical approach was adopted. In many cases where it is not possible to perform actual determinations of the individual dose, a possible method of using numerical indexes, whose connection with the doses, or at least whose conventional significance, will be clear, is suggested. (P.C.H.)

24805 ORGANIZING THE FIGHT AGAINST RADIOACTIVE CONTAMINATION IN NUCLEAR PLANTS. J. Rodier (French Atomic Energy Commission, Marcoule Centre, France). p.705-27 of "EUR-2210." (In English and French)

Methods used for the prevention of radioactive contamination in nuclear plants are discussed. The constant improvement of protective devices is stressed. (P.C.H.)

24806 ORGANISATION OF MEDICAL CONTROL OF RADIOACTIVE CONTAMINATION OF WORKERS IN A NUCLEAR PLANT. E. Mazaury (French Atomic Energy Commission, Marcoule Centre, France). p.729-42 of "EUR-2210." (In English and French)

Responsibilities of the Radiological Control Service and the Medical Service for the monitoring and control of radioactive contamination of workers in nuclear plants in France are discussed. The procedures used and control methods are described. (P.C.H.)

24807 EXTERNAL DECONTAMINATION. H. Wijker (Society for the Testing of Electrical Equipment, Arnhem, Netherlands). p.791-812 of "EUR-2210." (In English and Dutch)

A survey is given of the washing procedures, the solvents used, and the results obtained with these solvents in decontamination of the skin. Apart from washing, adhesive methods (tape, lacquer, solidified wax) or iontophores can be used for the removal of radioactive materials from the skin. The results obtainable with these methods are discussed. A few remarks are also made concerning the decontamination of the face and of burns. Excision may be suitable if the wound has been contaminated with insoluble radioactive material, since the dose in the tissue around such encapsulated material may be very high. A formula is given for the calculation of such doses on the basis of the MPC values for insoluble radioactive material in the lung as the critical organ. The contamination of wounds with suspensions and the suitability of excision in such cases are discussed. Recommended means of decontamination and possible sequence of use are appended. (P.C.H.)

24808 COLLECTIVE PROTECTION. F. Duhamel (Saclay Nuclear Studies Centre, France). p.753-89 of "EUR-2210." (In English and French)

The relation of group protection to the design, construction, equipment, and operating instructions in France is discussed. The three fundamental principles of the battle against contamination include: containment, control, and elimination. The methods used in each of these approaches are described. A general set of rules to determine the maximum activities that can be handled are appended. These rules depend on four conditions: laboratory lay-out and equipment; radioactive and chemical toxicities of the elements; physical state of the radioactive materials; and nature of the proposed operations. (P.C.H.)

24809 THE EFFECTS ON MARINE FOODSTUFFS OF A LARGE RELEASE OF RADIOACTIVITY INTO THE SEA. F. Morgan (Ministry of Agriculture, Fisheries and Food, Lowestoft, Eng.). p.153-61 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

Principles of evaluating the hazards of radioactive contamination of marine foodstuffs are presented and discussed. Examples are given to illustrate the feasibility of predicting the essential patterns of increase and decrease of contamination of important species following large releases of radioactivity. Those responsible for radiation protection in critical situations should thus be able to make considerable preparation before the event, to enable them to concentrate any available monitoring capability on charting a single basic parameter, i.e., the distribution of activity in sea water. (auth)

24810 POSSIBLE CONSEQUENCES OF RADIOACTIVE CONTAMINATION OF INNER OSLOFJORD. E. Foeyn (Univ. of Oslo) and S. H. Small. p.177-82 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

The fate of radioactive contaminants in Inner Oslofjord is discussed in the light of hydrographic studies. Contamination of the inner basins might persist for long periods due to the restricted tidal flow through Drøbak Sound. On the other hand, large volumes of contaminated water might be replaced fairly rapidly if the usual stratification of the water masses in the inner basins is disturbed by underwater detonations. (auth)

24811 SHIP AND TASK INFORMATION REQUIREMENTS FOR NUCLEAR DETONATIONS AT SEA. A. Dirvianskis and R. A. Sulit (Naval Radiological Defence Lab., San Francisco). p.185-92 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

The naval nuclear warfare problem is explored and the information requirements for naval operations in a radiological environment are related to the current state of the art. The requirements for nuclear detonation (NUDET), radioactive fallout (RADFO) prediction, and radioactive monitoring (RADMON) information are discussed for offensive and defensive naval operations. A specific example is presented for shipboard utilization. (auth)

24812 PROTECTION OF SHIPS AGAINST THE RADIOLOGICAL EFFECTS OF NUCLEAR WEAPONS. G. Giani (Ministero Difesa–Marina, Maricominav, Rome). p.193-201 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

The effects of conventional weapons (shells, mines, bombs, torpedoes, etc.) on ships and the means of counteracting and reducing the resulting damage, are nowadays well known from experience during World War II. Nuclear weapons may cause similar although far more extensive damage, and the countermeasures can in certain respects be the same. However, nuclear weapons bring an additional and completely new effect, the radiological one, that does not cause structural damage to ships, but may greatly affect the efficiency and physical wellbeing of ships crews. (auth)

24813 SHIP RADIOLOGICAL COUNTERMEASURES: THE CONTAMINATION-DECONTAMINATION OF FISSION PRODUCTS IN SEA WATER. R. N. Anderson and L. H. Gevantman (Naval Radiological Defence Lab., San Francisco). p.203-16 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

With the advent of the first weapons test at Bikini (Operation Crossroads) ships stationed in the vicinity of the nuclear detonation were found to be structurally undamaged but contaminated with radioactive fallout making an extremely hazardous situation for operating personnel. This led to a consideration of the problem of countermeasures in which protection from or subsequent removal of the fallout from the weather surfaces of the ship by prescribed methods would allow the ship to carry out its assigned missions. Investigations into the nature of sea water fallout disclosed that many of the fission products were ionic in nature and chemically reactive to a variety of surfaces. Therefore laboratory experimentation has placed considerable emphasis on the nature of such fission product interaction with surfaces. Trace concentrations of selected

fission products in solution, either individually or as mixtures, were deposited on a variety of one inch squares and allowed to dry. They were then decontaminated in a number of ways, each aimed at assessing the efficiency of removal and extending the method to full scale. The information gained from these tests has led to present tests which involve the contamination of up to 2,000, 0.5 square foot painted plates with a sea water simulant. The contamination characteristics of La, Ba, Zr, and Nb radionuclides have been studied singly in the simulant. Results show that La is more difficult to remove than Ba because of its higher valence. In addition surfactants when added to the decontaminating solution have proven generally ineffective. The present stage of countermeasure development includes operational ship washdown systems which have been shown to be effective. Evaluation has yet to be made on the usefulness of a protective strippable coating. Future research will continue along these lines of development. (auth)

24814 REGULATORY STANDARDS FOR IRRADIATED FUEL SHIPMENTS. A. E. Aikens and B. G. Lindberg. 12p. (CONF-650103-11)

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

The design and performance standards for containers for shipping irradiated fuels, as set out in the AEC's transportation regulations, are considered. The design standards specify minimum numerical limits or factors of safety, which must be observed during the design of the package. The performance standards essentially specify safety requirements, which must be met during postulated normal or accident test conditions. The things an application for license should contain in order to show that the regulatory requirements are met are listed. The regulatory safety assessment is discussed. Three repetitive problem areas were: an adequate determination of failure temperature of the cask's contents, the extent of cask damage due to impact, and the extent of cask damage in a severe thermal environment. (M.C.G.)

24815 PRESSURE VENTING DEVICE FOR SPENT FUEL ELEMENT SHIPPING CASKS. E. C. Lusk (Battelle Memorial Inst., Columbus, Ohio). 4p. (CONF-650103-7)

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

A device was developed and tested, which will safely vent steam from the lead cavity of a cask for shipping spent fuel elements. The device is of stainless steel and machined to a funnel shape. The small end is threaded with a standard pipe thread to fit into the side of the cask. The size of the opening is determined by the flow rate required as calculated from fire test data. The large end of the funnel is capped by a plate of porous stainless steel. A second cap made of stainless steel plate with holes filled with a low-melting alloy covers the porous steel cap. The alloy used to fill the holes melts at 195°F so that holes will open before any steam is formed. The porous stainless steel plate controls the flow of molten lead up to a pressure of 42 psig under fire conditions. (M.C.G.)

24816 TESTING OF 3M SHIPPING CONTAINERS FOR ENRICHED URANIUM. W. E. Rowe and R. H. Fredrickson (Minnesota Mining and Mfg. Co., St. Paul). 19p. (CONF-650103-9)

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

The containers used for shipping of enriched uranium fuel materials were tested by subjecting two containers to the test sequence prescribed by the AEC. The containers utilize 55-gallon type ICC-17H steel drums with a nominal 5 in. ID center tube of stainless steel. The tube is sealed with a gasket and flange. The containers utilize a steel pyramid on each drum to prevent stacking during shipment or storage. One complete cycle of tests was run on each of the two containers tested. The first container utilized a neoprene gasket in the flange, and the second utilized a special inconel-asbestos gasket. Less than a pint of water was observed to leak into the inner container in each case after completion of these tests. (auth)

24817 FIRE TESTING OF ISOTOPES SHIPPING CONTAINERS. Leonard Horn (Underwriters' Labs., Inc., Chicago). 10p. (CONF-650103-10)

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

Results of several fire tests on shipping containers for radioactive materials are presented. Testing facilities and procedures are described. Data are presented in graphs and pictures taken during the tests are included. It was concluded that a properly designed wood shield can give good protection to a lead-shielded shipping container for a standard 1 hr fire exposure. (M.C.G.)

INSTRUMENTATION

General

Refer also to abstracts 24479, 24611, and 25071.

24818 (DP-953) SOLID-STATE DC AMPLIFIER WITH HIGH INPUT IMPEDANCE. Joseph S. Byrd (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Feb. 1965. Contract AT(07-2)-1. 14p. Dep.; $1.00(cy), 1(mn) CFSTI.

A solid-state operational amplifier with a field-effect transistor at the input was designed and tested. The amplifier has an input resistance greater than 5×10^{11} ohms and an input leakage current less than 10^{-12} ampere at room temperature. The amplifier is useful in nuclear instrumentation applications where it is necessary to measure very small signal currents. (auth)

24819 (HW-76326) A SOLID-STATE TIME-DELAY RELAY DEVELOPED FOR USE IN 234-5 BUILDING FILTER BLOWBACK CYCLE PROGRAMMERS. C. E. Huck (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 25, 1963. Contract AT(45-1)-1350. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The solid state time delay relay has a time cycle manually variable from 0.2 to 5.5 seconds and is repeatable to about ±1% of the time setting. Performance of the relay is therefore adequate, as developed, for accurately programming the blowback cycle of the 234-5 Building glove box filters as well as for other applications requiring an accurate time delay relay with a manually adjustable time cycle. (auth)

24820 (MATT-292) IMAGE CONVERTER CAMERA FOR 0.5 TO 10,000 MICROSECOND PHOTOGRAPHS. H. L. Miller (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1964. Contract AT(30-1)-1238. 29p. Dep.; $2.00 (cy), 1(mn)CFSTI.

Equipment is described for making photographs using an image converter tube as an electronic shutter. When operating in the framing mode, the camera will take three frames 10 to 10,000 μsec apart with exposure times from 0.5 to 2000 μsec. Each frame has a maximum diameter of 25 mm. When operating in the streak mode, the camera has streak times from 10 to 10,000 μsec. The streak picture is about 60 mm long and 25 mm wide. The equipment uses the RCA 73435D image converter tube. A standard oscilloscope camera is used to record the images. Design of the equipment is discussed and circuits for controlling and timing the photographs described. (auth)

24821 (NAA-SR-10511) INCREASING THERMOCOUPLE RELIABILITY FOR IN-PILE EXPERIMENTS. E.L. Babbe (Atomics International, Canoga Park, Calif.). Apr. 20, 1965. Contract AT(11-1)-Gen-8. 42p. Dep.; $2.00(cy), 1(mn) CFSTI.

As temperature and reactor residence time requirements for in-pile experiments increase, thermocouple failures have become more numerous. Because thermal cycling conditions cause failure rates to increase, laboratory-produced thermal shock tests were performed. The results indicate that increased reliability can be obtained by using thermocouples made with insulation of increased density and/or a low thermal expansion sheath. (auth)

24822 (SC-TM-64-2154) A VOLTAGE BREAKDOWN DETECTOR. E. L. Shaffstall (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract [AT(29-1)-789]. 7p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

A description is given of the application of a tunnel diode voltage level detector to monitor components for voltage breakdown during pulse testing. (auth)

24823 (SC-TM-65-63) DATA FILTER CHARACTERISTICS AND EFFECTS. J. L. Mortley (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract [AT(29-1)-789]. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The use of data filters in electronic circuits is normally considered undesirable because filtering irretrievably eliminates desirable as well as undesirable information. Filtering is necessary in some applications, however, to obtain any useful information from measurements made in high-noise and distorted environments and from FM tape-recording and carrier-frequency-type systems. A discussion is presented of related theory and special filter characteristics necessary for retaining the maximum useful information in a filtered signal, depending upon whether the desired data are periodic or transient in nature. (auth)

24824 (SC-TM-65-106) GUARDED CIRCUITS. R. K. Treece (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract [AT(29-1)-789]. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An outline is presented of the theory of guarded, high-impedance circuits. Two examples are used to illustrate guarding techniques and to indicate areas of practical application. (auth)

24825 TRANSISTOR SWEEP CIRCUIT FOR A SUPERCONDUCTING SOLENOID. J. A. Hulbert and G. R. Wilson (Royal Radar Establishment, Malvern, Worcs., Eng.). J. Sci. Instr., 42: 293-4(Apr. 1965).

A current sweep circuit for a superconducting solenoid is described, which uses a single output transistor that will operate reliably at 30 amp on a heat sink (200 $in.^2$) cooled by natural convection. The circuit provides sweep times of up to 45 min. Higher output currents can be obtained with a water-cooled heat sink. (D.C.W.)

24826 A NOISE-FREE CHARGE-SENSITIVE PREAMPLIFIER WITH FIELD EFFECT TRANSISTORS. O. Meyer (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instr. Methods, 33: 164-6(Mar. 1, 1965). (In German)

The utilization of low-noise field effect transistors in a low-noise preamplifier was investigated. The optimum grid voltage for the signal noise ratio and the optimum anode voltage were determined. The preamplifier circuit is given. The characteristics determined were tabulated. The half-value width of the amplifier noise was determined as a function of the time constant. (J.S.R.)

24827 CIRCULAR PHI-CHI MOTION DEVICE (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). 35 drawings. (CAPE-1124)

A goniostat used in determining crystal structure to obtain three-dimensional intensity data by x-ray or neutron diffraction is described. The device has 360° phi motion, 360° chi motion, an accuracy of setting these two angles to a hundredth of a degree, digitizer coupling and readout for each angle, ability to automatically program the angle settings, and minimum blanked out areas. The instrument consists of a ring with both phi-chi motion. A goniometer is mounted in the ring. A limited omega manual adjustment is incorporated in the base of the goniostat. This movement is indexed to 0.01° intervals over a 10° range and is intended for alignment. (For details, see TID-4100) (D.C.W.)

24828 ELECTRONIC TIMER /Q-2706/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). 1 drawing. (CAPE-1159)

An inexpensive timer with digital accuracy is described, which replaces bulky, motor-driven timers of limited accuracy. It is used in any application to "start" and "stop" an operation after any time interval and is adjustable in 1-sec increments from 1 to 9999 sec. The variation in time interval is less than 5 msec at any setting. The output from the timer is in the form of an electrical pulse, occurring at the start and the end of the selected time interval. The timer uses a 10-cps mechanical oscillator as the clock and a four digit pre-set, count-down register. The desired time interval is dialed by the operation of the thumbwheels of the count-down register. Upon activation of a start push-

button, the countdown proceeds until the register indicates 0000. Then, the register must be reset electrically with another pushbutton prior to another timing operation. A Q-880-79 power supply controls the flip-flop for the register drive. (For details see TID-4100) (D.C.W.)

24829 RADIOGRAPHIC APPARATUS AND METHOD. Kenneth MacGregor Swanson and Alan George Kerswell (to United Kingdom Atomic Energy Authority). British Patent 966,877. Aug. 19, 1964. Filed Mar. 28, 1961.

A radiographic apparatus to project an image of a specimen onto a screen by x or γ radiation is reported. A disc of radiation arresting material is interposed between the specimen and the screen. The disc is mounted for rotation about an axis alignable with the radiation source and is formed with radiation transparent slits extending radially of the axis. For a radioactive sample a shielded cell is provided, and the disc acts as a filtering device to prevent γ radiation from the samples from blackening the film uniformly to the detriment of the image. (B.L.M.)

24830 PRESSURE-SENSITIVE TRANSDUCER. Wellesley Ashe Kealy, Richard Smart, and Edward Duncombe (to United Kingdom Atomic Energy Authority). British Patent 966,884. Aug. 19, 1964. Filed Mar. 6, 1961.

A pressure-sensitive transducer that can be made very small is applicable to the indication of pressure and temperature at locations remote from the point where measurement is to be made, e.g., the temperature of a reactor fuel element. The transducer includes a diaphragm within a fluid filled chamber. Preferably the diaphragm is penetrated by an aperture to balance the fluid pressure on each side of the diaphragm. An electro-magnetic coil vibrates the diaphragm. The resonant frequency of the diaphragm that is dependent upon the pressure of the fluid within the chamber is detectable by the effect of resonance on the impedance offered by the coil. Several embodiments of the transducer for particular applications are reported. (B.L.M.)

24831 TEMPERATURE MEASURING APPARATUS. Wellesley Ashe Kealy and Richard Smart (United Kingdom Atomic Energy Authority). British Patent 966,885. Aug. 19, 1964. Filed Aug. 3, 1961.

A temperature measuring apparatus suitable for use in measuring the temperature of reactor fuel elements includes an a-c transducer secured to the fuel element to indicate the temperature of a reference point on the element and a thermocouple having one junction at the surface of the element so that it indicates the differential between the reference point and the surface of the element. Connections are provided for combining the a-c signal with the d-c signal from the thermocouple to provide a single output signal from the apparatus. The a-c transducer is made up of a fluid filled chamber with one junction of the thermocouple in thermal contact, a diaphragm within the chamber, and an electromagnetic coil for vibrating the diaphragm. The frequency of the diaphragm is independent upon the temperature of the fluid in the chamber and is detectable by the effect of resonance on the electrical impedance offered by the coil. (B.L.M.)

24832 IMPROVEMENTS IN OR RELATING TO A GAS SAMPLING APPARATUS. Samuel Brittan Hosegood, Eric James Mitchell, and Cecil Harper (to United Kingdom Atomic Energy Authority). British Patent 966,977. Aug. 19, 1964. Filed Dec. 9, 1960.

The gas sampling apparatus is chiefly concerned with selective sampling of a number of gas streams that are derived from gaseous coolant or fission product purge gas from nuclear reactors. The apparatus includes a valved body having a number of inlet ducts for gas to be sampled and a corresponding number of valves arranged to communicate the ducts with a source of flushing gas when the valves are in the first position and with a sampling location when the valves are in the second position. Means are provided for maintaining the valves in the first position and for moving any selected valve to its second position. In order to achieve a back flushing effect, the direction of gas flow in the inlet ducts when the valves are in the first position is opposite to the flow direction when the valves are in the second position. (B.L.M.)

24833 IMPROVEMENTS IN OR RELATING TO ELECTRON MULTIPLIERS. Etienne Picard and Andre Sala (to Commissariat a l'Energie Atomique). British Patent 977,827. Dec. 16, 1964. Priority date Feb. 9, 1960, France.

A process and a device for the automatic control of electrode potentials in an electron multiplier is reported. With the device measurement of radiation can be made even when the intensity varies between extreme limits. The ratio of the output current intensity of the electron multiplier remains small, of the order of 1 : 10 while the ratio of the intensity measurements may be $1 : 10^4$. The device considerably increases the measurement scale while the maximum value of the mean intensity of the output current of the multiplier and the amplitude of the variation of this current are decreased. It is also possible to use a linear amplifier of greater precision at the output of the multiplier with the potential controller. (B.L.M.)

24834 IMPROVEMENTS IN OR RELATING TO RATEMETERS. Charles Holmes Vincent and John Brian Rowles (to United Kingdom Atomic Energy Authority). British Patent 978,749. Dec. 23, 1964. Filed Aug. 16, 1962.

An electrical pulse ratemeter that is not based on a capacitor but uses a digital technique is patented. The ratemeter is designed to include a digital addition circuit, means for subtracting at predetermined intervals of time a number forming a constant fraction of the number in the addition circuit, and means for exhibiting a reading corresponding to the number forming the constant fraction. The digital addition circuit receives electrical pulses and adds one unit for each pulse. (B.L.M.)

24835 RADIOACTIVITY SOURCE-AND-DETECTORS DEVICE FOR MEASUREMENT OF PROPERTIES OF MATERIALS. Ariel G. Schrodt and Philip Shevick (to Nuclear-Chicago Corp.). U. S. Patent 3,159,745. Dec. 1, 1964. Filed June 17, 1960.

The radioactivity measuring instrument provides a construction in which the requirements for servicing are substantially reduced as compared with conventional systems. The instrument includes a number of successive counters in a planar array extending away from the source in two directions. The counters are of the conventional BF_3 gas type, and the successive counters on each side are interconnected by gas passages. Gaseous diffusion between the counters automatically equalizes the consumption of neutron absorber in all the counters, thus fully utilizing the lifetime capabilities of all members of the set of counters without intermediate servicing operations that involve economic waste. (B.L.M.)

24836 RADIATION GAUGING SYSTEM FOR MEASURING THE PROGRESS OF SETTLING IN SLURRIES AND SUSPENSIONS. George B. Foster (Industrial Nucleonics Corp.). U. S. Patent 3,160,745. Dec. 8, 1964. Filed May 19, 1961.

In a system for conveying a fluid containing suspended particles from one point to another, an apparatus for measuring the progress of settling of the particles under gravity is described. The apparatus is comprised of means for conveying the fluid horizontally and without agitation through a test zone and two radiation sources and detectors for observing the relative radiation or scattering at the upper and lower portions of the pipe. The output of the two detection devices are compared, and the uniformity of the particle density of the medium then is obtained. The device is applicable to the determination of the mass divergence in slurries, colloidal dispersions, and aerosols. (B.L.M.)

24837 ION ACCELERATION APPARATUS FOR COINCIDENCE TIME-OF-FLIGHT MASS SPECTROMETERS. Austin L. Wahrhaftig, Marvin L. Vestal, Manfred Krause, and William H. Johnston (to William H. Johnston Labs., Inc.). U. S. Patent 3,163,752. Dec. 29, 1964. Filed Aug. 20, 1962.

The apparatus patented is intended to accelerate ions between a source and a detector with both high resolution and high efficiency. The first of a pair of electron lenses between the ion source and the detector is slightly diverging in operation. The second lens is convergent in action upon the ion beam and operates to change the diverging beam into a substantially parallel beam, which is supplied to the detector. A relatively low field intensity is employed between the first lens plate and the ionization region, and a relatively high field intensity is employed farther away from the ionization region. The convergent lens is separated from the ion detector by a field-free dirt region. In a mass spectrometer wherein both electrons and positive ions are detected, a similar arrangement is employed between the ionization region and the electron detector. (A.G.W.)

24838 TRANSISTORIZED LOADING CIRCUIT. Richard H. Graham. (to U. S. Atomic Energy Commission). U. S. Patent 3,177,373. Apr. 6, 1965.

Multivibrator loading circuits, more particularly, a loading circuit coupled to the emitter of one transistor in a conventional transistor multivibrator, are described. In a multivibrator employing two transistors in the conventional common emitter configuration, the emitter of one of these transistors is coupled, instead of directly to ground, to the emitter of another transistor whose base is connected directly to ground and whose collector connects through a resistor to a collector power supply. With this arrangement, the transistor emitter in the conventional multivibrator is effectively coupled to ground since the grounded base transistor amplifier configuration inherently has a low emitter to base impedance. As a result, it is possible to obtain large voltage swings at the collector of the grounded base transistor with virtually no concomitant degradation of multivibrator lifetime or stability. (AEC)

24839 SERVO-STABILIZED ANALOG-TO-DIGITAL CONVERTER FOR HIGH RESOLUTION PULSE ANALYSIS. R. L. Chase (to U. S. Atomic Energy Commission). U. S. Patent 3,177,482. Apr. 6, 1965.

A transistorized analog-to-digital converter is described, in which a servo system is utilized to obtain an accuracy of over one part in four thousand. The analog pulses each fall into one of over four thousand channels and two of the channels are selected for control. In these channels, digital error pulses are accumulated and when accumulated to an appreciable value a correction is introduced to the converter circuits. (AEC)

Radiation Detection

Refer also to abstracts 24382, 24744, 25192, 25218, 24655, and 25693.

24840 (CRGP-1214) SOME FOCUSING PROPERTIES OF AN IRON ORANGE β-RAY SPECTROMETER. J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 21p. (AECL-2237) Dep.(mn); $1.00(AECL)

In order to obtain information necessary for the design of a seven-element detector array, a study was made of the width of the image formed by electrons focused by different parts of one gap of the Chalk River orange beta spectrometer. The focused image profiles were recorded on no-screen x-ray film. Results are presented for focal cylinder radii of 15.6 mm and 41.9 mm. The variation of the focusing magnetic field strength with orbit position in the gap is given for focal cylinder radii of 15.1 mm and 40 mm. The relevance of the present findings to the focusing of 6-gap orange beta spectrometers is considered. (auth)

24841 (FZK-208) DEVELOPMENT AND APPLICATION OF NUCLEAR MEASUREMENT TECHNIQUES. W. E. Dungan, J. K. Miles, and J. R. Bell (General Dynamics/Fort Worth, Tex.). Mar. 1965. Contract AF29(601)-6213. 78p. (WL-TR-64-160)

A study program was performed on the selection of high-temperature materials for use as passive neutron-field-measuring devices and of thermal-neutron shields for use in extreme nonnuclear environments. Seventeen candidate materials were investigated from which four compounds were selected as most suitable for high-temperature neutron detectors. Also, five high-temperature cements were investigated for possible use as binders in pellet fabrication, and two were found to be acceptable. A limited amount of information is given on the feasibility of replacing cadmium thermal-neutron shields with cadmium oxide shields in high-temperature environments. Facility calibration procedures and results are presented for the modified GTR irradiation chambers, pneumatic tubes, and standard-pile facilities. Also discussed is the interfacility comparison of sulfur-pellet calibrations conducted jointly with three other nuclear facilities. Preliminary results are presented of an experiment performed to reevaluate the counting efficiencies of the NARF end-window counters for commonly used foils. (auth)

24842 (HW-63247) SCINTILLATION AREA MONITORING SYSTEMS. W. G. Spear (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 1, 1960. Contract AT(45-1)-1350. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Efforts were made to develop satisfactory linear and logarithmic beta-gamma area and criticality alarming monitoring instrumentation. The results showed scintillation detectors to be reliable and to require only simple and straightforward circuitry. For both linear and logarithmic systems, the response time, zero drift, beta-gamma response, stability of operation, and calibration accuracy are all improved over other systems. The scintillation system gamma-energy dependence is surpassed only by the insensitive standard air-wall chamber system. Any alarming device of the 110 VAC-operated type can be incorporated with either system, and the detector probe can be located several hundred feet from the indicating and power supply unit. The approximate cost per point excluding recorder, for the linear scintillation system is about $400. The approximate cost per point, excluding recorder, for the logarithmic scintillation system is about $550. (P.C.H.)

24843 (LA-3228) MODEL 200 AC/DC AIR SAMPLER. Morris J. Engelke (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Feb. 1965. Contract W-7405-eng-36. 20p. Dep.; $2.00(cy), 1(mn) CFSTI.

The Model 200 AC/DC air sampler is a completely portable, compact instrument for the qualitative detection of radioactive gases in the atmosphere. It is used in this Laboratory primarily for the detection of tritium in the air in concentrations greater than 50 $\mu Ci/m^3$. The operation, maintenance, and performance in the field of the air sampler are described. (auth)

24844 (LA-DC-6637) STATUS AND APPLICATION OF THERMOLUMINESCENT DOSIMETRY SYSTEMS. Edwin A. Bemis (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 33p. (CONF-727-5). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 10th Annual Bioassay and Analytical Chemistry Meeting, Cincinnati, Oct. 1964.

The theory of thermoluminescence is discussed. Several commercial thermoluminescent dosimetry systems are described briefly as being representative of systems of this type. Difficulties in making the measurements are considered. Some of the applications of thermoluminescent dosimeters are outlined. (D.L.C.)

24845 (NP-14963) NON-DESTRUCTIVE ANALYSIS OF IRRADIATED FUEL ELEMENTS BY ESTABLISHING A RELIABLE CORRELATION BETWEEN ONE OR MORE GAMMA LINES FROM THE FISSION PRODUCTS AND THE BURN-UP OF IRRADIATED FUEL ELEMENTS OR SAMPLES. Final Report. Nils Ryde (Chalmers Tekniska Hogskola, Goteborg (Sweden)). [1964]. 42p. Dep.(mn).

Includes four progress reports.

A description is given of the design, construction, and calibration of a crystal diffraction spectrometer for nondestructive analysis of the degree of burnup in irradiated fuel elements. By measuring the intensity of gamma ra-

diation emitted from several different fission products, a detailed picture of the burnup and its distribution can be obtained. This necessitates an instrument possessing a high resolving power in the energy range from 50 to 1500 kev. (W.L.G.)

24846 (PG-Report-627) METHOD FOR THE CALIBRATION AND CONTROL OF A GAMMA-RAY SPECTROMETER. (Production Group, United Kingdom Atomic Energy Authority, Sellafield (England)). 1964. 25p. Dep.; $0.80(BIS), 4s. (HMSO).

In order to carry out quantitative analysis of gamma ray spectra, a calibrated spectrometer is required. The method of setting up and subsequently calibrating such a spectrometer is described. Methods of controlling the performance of the instrument and testing its operation are also described. An indication is given of the way the data obtained from a set of standard spectra can be reduced into forms convenient for application to quantitative analysis. (auth)

24847 THE QUENCHING BY A MAGNETIC FIELD OF ENHANCED PULSES IN A SILICON RADIATION DETECTOR. Hubert P. Yockey and Norman A. Baily (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Letters, 6: 163-4(Apr. 15, 1965).

The effects of an applied magnetic field on multiplication phenomena in a Si semiconductor detector were studied using a n-p-n structure made by evaporating Al on both sides of a p-type Si wafer. Alpha particles from a ^{212}Po-^{212}Bi source were allowed to fall alternately on the positively and negatively biased barrier surfaces. With a magnetic field transverse to the applied electric field, the larger effect was observed for particles entering the negatively biased surface. This observation and observations with a parallel magnetic field are consistent with a dependence of the degree of multiplication on the path length of electrons in the device. (D.C.W.)

24848 THE DEPENDENCE OF COUNTING EFFICIENCY OF RECORDING OF FAST NEUTRONS ON THE GEOMETRY OF ORGANIC SCINTILLATORS. V. G. Zolotukhin and G. G. Doroshenko. At. Energ. (USSR), 18: 287-90(Mar. 1965). (In Russian)

Interpolation graphs were developed for the counting efficiency of Monte Carlo method recording of stilbene crystal in four cylindrical geometries. Calculations for each geometry were carried out with 55 initial neutron energies ranging from 0.5 to 18 Mev. The energies were selected according the cross sections of neutron reactions with carbon nuclei. The calculations were carried out with the order of accuracy of 0.2 to 0.8%. The influence of carbon resonance cross section was well pronounced in all geometries. The comparisons of Monte Carlo method with the method of a single (n-p) scattering approximation showed that the (n-p) approximation is efficient for measuring at energies up to 10 Mev; more precise data can be obtained from the interpolated graphs. (R.V.J.)

24849 CURRENT—INPUT AMPLIFIERS FOR NUCLEAR PULSE SPECTROMETRY. William M. Trenholme (Massachusetts Inst. of Tech., Cambridge). Atomics, 18: 37-8(Jan.-Feb. 1965).

The advantages of using linear pulse amplifiers with current input in spectrometry are summarized, and the application to spectrometer systems using scintillation detectors is briefly discussed. The output pulse amplitudes obtained for several scintillation phosphors with current and voltage inputs to a typical spectrometer amplifier are compared. (D.C.W.)

24850 INVESTIGATIONS ON HOLLOW IONIZATION CHAMBERS FOR THE MEASUREMENT OF THE ION DOSE IN X-RAY AND GAMMA RADIATION IN THE PHOTON ENERGY RANGE BETWEEN 100 kev AND 1.3 Mev. B. A. Engelke and W. Huebner (Physikalisch-Technische Bundesanstalt, Brunswick). Biophysik, 2: 193-211(1965). (In German)

A cavity ionization chamber, that was prepared as cylindrical parallel-plate chamber and was irradiated in the direction of the cylinder axis, is described. Its suitability for the absolute determination of the standard ion dose output, of the Bragg-Gray ion dose output in a 350-kv x radiation, and the gamma radiation of ^{137}Cs and ^{60}Co was investigated. The effects of phantom and chamber wall material, chamber dimensions, etc. were determined. The correction factors that must be considered in the determination of the Bragg-Gray or standard dose output from the measured ionization current, the measurement volume, and the air density were also determined. The material and energy dependence of the correction factors k_{BG}, which consider the deviation of the measurement conditions from the assumptions for the Bragg-Gray principle, was investigated. The chamber is suitable for the absolute determination of the ideal Bragg-Gray ionization dose output (maximum uncertainty ±3.5%), which permits a simple calculation in the corresponding energy dose output with the Bragg-Gray relation, at photon energies over about 500 kev in phantom materials with low atomic numbers ($Z < 15$). An absolute determination of the standard ion dose output is possible with this cavity chamber at photon energies below 1.5 Mev in a graphite phantom with a maximum uncertainty of ±2.3%. (tr-auth)

24851 ON THE STRETCHERS EMPLOYING THE ADDED-STEP TECHNIQUE. G. Binda, P. F. Manfredi, and A. Rimini (CESNEF, Milan). Energia Nucl. (Milan), 12: 230-2(Apr. 1965).

Evidence of some difficulties which are inherent in the added-step technique for stretching short pulses is pointed out. (L.B.S.)

24852 CHOICE OF EQUIPMENT FOR MONITORING EMERGENCY SITUATIONS. H. Kiefer and R. Maushart (Kernreaktor Bau- und Betriebsgesellschaft, Strahlenmessabteilung, Karlsruhe, Ger.). Food Agri. Organ. U.N., FAO At. Energy Ser., No. 5, 288-98(1964).

Radiation detectors and radiation detection instruments are evaluated as to usefulness for monitoring in emergency situations. Emphasis is placed on portable and mobile radiation measuring equipment. The relative merits of battery-powered count-rate meters with G-M tubes, dose rate measuring equipment with ionization chambers as detectors, scintillation detectors, γ spectrometers, and proportional counters for use in monitoring air, water, and foodstuffs after a radiation accident are discussed. (C.H.)

24853 BUBBLE CHAMBER AND DATA PROCESSING DEVICE. Kita Isao. Genshikaku Kenkyu, 8: No. 1, 2-7 (1963). (In Japanese)

The bubble chamber used in the 12-Bev PS program is described. It is pointed out that the bubble chamber is valuable to high energy accelerator experiments on account of its unique features but presents considerable difficulties in data processing because the measurement of the tracks on the photographic negatives is complicated and time-consuming. The problems which must be solved before the rate of its data processing can be made to catch up the pre-determined cycle of the 12-Bev PS—16 c/sec. chamber operation are discussed. (L.B.S.)

24854 A SANDWICH TYPE HIGH ENERGY γ-COUNTER. Kitakaki Toshio. Genshikaku Kenkyu, 8: No. 1, 69-75(1963). (In Japanese)

A sandwich type high energy γ counter consisting of alternately arranged lead plates and plastic scintillators is described. The total electron energy may be calculated from the energy loss in ionization suffered by the electrons in the plastic scintillators when cascade showers of electrons are produced in the lead plates by the incident γ radiation. This type of counter has better resolution, lighter weight and easier operation than the Cherenkov counter, although it has a rather higher background. It is indicated that 90% of the energy of the incident γ radiation may be absorbed by this type of counter and the energy loss in ionization by showers of electrons produced in the plastic scintillators ~30%. The scintillations enter the photo-cells whose photon collecting rate is approximately 2%. About 500 photons may be produced by a 100 Mev incident γ-radiation. The following results are obtained from two experiments on μ-mesons from cosmic rays with this type of

counter. In the first experiment, two 1 × 10 × 10 cm scintillating telescopes were placed above and below the counter. Their pulses triggered the gate and the pulses of the sandwich counter were then recorded. The experimental results show that its resolution for μ peak is > E/E ≈ 20% and its distribution curves are slightly deviated from Landau distribution in the initial part. In the second experiment, only scintillator was used instead of opening the gate of the telescope. Pulse height analysis showed that there was considerable background of electron noise (at low energy) and cosmic rays, and therefore the incorporation of anti-counter should be considered. This type of counter may be calibrated with monochromatic electrons. The calibration is accomplished by feeding the sandwich counter the monochromatic electrons selected by a magnetic analyser from the bremsstrahlung which is fed to a converter from an electron synchrotron. The pulses from this counter enter eventually a multi-channel analyser through a photomultiplier, an amplifier and a linear gate. (NFSAIS)

24855 NEUTRON MONITOR USING A TRANSISTORIZED ELECTRIC CIRCUIT. V. Kh. Leonov and E. A. Mazaryuk (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetizm i Aeronomiya, 4: 1101-5(1964).

A transistorized neutron monitor designed for high-stability operation at a high noise level with an input sensitivity of several millivolts is described. It consists of a preamplifier, a shaper-amplifier, an anticoincidence circuit, a scaling device with a mechanical counter, and a high-accuracy recording unit. The preamplifier is an input stage and an amplifier using two transistors enveloped with deep negative feedback. The input stage utilizes a 1 Zh24B miniature tube (filament current, 11 mamp; life, 5000 hr; plate load, 3 kohm; input resistance, approximately 3 Mohm; gain, 3). The total gain of the preamplifier does not exceed 20. The shaper-amplifier consists of an amplifier similar to the one included in the preamplifier and a blocking-oscillator which serves as the shaping stage. The total gain can be varied from 5 to 30. The operational threshold of the blocking-oscillator is smoothly adjusted by a potentiometer. The anticoincidence circuit utilizes P 15 transistors and also consists of preamplifier, amplifier, and blocking oscillator. (CFSTI)

24856 NEUTRON DOSIMETRY USING GOLD AND SULPHUR: THE CALIBRATION OF A GEIGER-MÜLLER COUNTER. S. J. Boot and J. A. Dennis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Sci. Instr., 42: 248-51(Apr. 1965).

The efficiency of an end-window Geiger–Müller counter was determined for the measurement of gold foil and sulphur disk beta activities to enable slow and fast neutron fluxes to be estimated from a personnel dosimeter. The counter efficiency for gold foils was obtained from measurements of the combined effects of backscattering and absorption of beta particles in a thick gold foil, and the efficiency for ^{32}P contained in a sulphur disk was found by crushing the disk and suspending the powder in a thixotropic gel contained in a calibrated liquid counter, the latter result having been confirmed by two other methods. Impurities in the sulphur give rise to slow neutron activations which interfere with the ^{32}P activity measurement. A study of the beta decay and gamma spectra of these impurities has allowed them to be identified. (auth)

24857 A LOW NOISE CHARGE SENSITIVE AMPLIFIER FOR USE WITH SOLID STATE RADIATION DETECTORS. S. Z. R. Hashmi (Univ. of Texas, Austin). Indian J. Pure Appl. Phys., 3: 107-9(Mar. 1965).

Circuit details and noise characteristics of an improved charge-sensitive amplifier using the 8058 Nuvistor tubes, are described. The amplifier employs negative charge feedback in order to keep the output amplitude essentially independent of the value of the detector capacitance. A noise line width of nearly 5 kv is obtainable for best overall performance. (auth)

24858 THE ENERGY DEPENDENCE OF COLLIMATOR PARAMETERS IN SCINTIGRAPHY WITH SPECIAL RESPECT TO THE NUCLIDE I^{125}. M. Tautz (Stadtische Klinikums, Berlin). Kerenergie, 8: 105-15(Feb. 1965). (In German)

Physical proof is given showing that quantum-energy dependence of collimator parameters points out the limits, and also the advantages of scintigraphy by means of radionuclides in the energy-range investigated. Low-energy nuclides show better resolving power which is of fundamental meaning for clear diagnostics. As an example, using ^{125}I instead of ^{131}I whose quantum energy is 12 times higher than ^{125}I is an important advantage that not only includes improvement of information from the scintigram, lower body burden of the patient, and more economic operating of the scanner, but also acts drastically on the design of the whole moving devices of the scanner. The scintigrams obtained showed that the demands made for introducing this radionuclide in clinical practice are justified. It is of interest to force studies of low-energy gamma-ray emitters in order that radionuclides of improved properties with respect to diagnostic features may also be used in other fields of scintigraphy. (auth)

24859 AREA-RADIATION MONITOR WITH EMERGENCY ALARM. Kentaro Minami and Hayao Kuroda (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 144-8(Mar. 1965). (In Japanese)

An emergency area-radiation monitor which has good stability and is free from erroneous actuation through powerline accidents was perfected. The detector consists of a plastic scintillator and a photomultiplier. The anode of the photomultiplier is connected to the ground through a highly insulated capacitor. The anode is also connected to a rate meter through a neon lamp, so that the current can be converted into pulses which are counted by a rate meter, eliminating the possibility of triggering by electric disturbances. Furthermore, an advantage of this current-measuring type monitor is the improvement of energy response by the use of plastic scintillator as compared to ionization chambers. The range of detectable radiation dose of this monitor is from 1 mR/hr to several R/hr. (auth)

24860 HOW TO DETERMINE EFFICIENCY AUTOMATICALLY IN LIQUID SCINTILLATION COUNTING. [Elizabeth T. Bush]. Nucl.-Chicago Tech. Bull., No. 13, 3p.

In liquid scintillation counting the efficiency dependent on the physical-chemical nature of the sample, which includes the entire volume of material contained in the sample holder, including the solvent system, fluors, and the radioactive material to be counted. The theory and advantages of the channels ratio method for automatically determining the efficiency are discussed. Tritium and ^{14}C quenching correction curves are given. Use of quenched standards, samples with low counting rates, and three-channel liquid scintillation counting are discussed. (M.C.G.)

24861 BACKGROUND SUPPRESSION: A NEW GENERAL METHOD IN THE MEASUREMENT OF IONIZING RADIATION. J. E. S. Bradley and J. Marks (Middlesex Hospital Medical School, London). Phys. Med. Biol., 10: 191-200(Apr. 1965).

A description and analysis are given of the application of modulation methods in the recording of ionizing radiation. This provides a new general method, which overcomes many existing difficulties for the case $S^2/B \leq 1$, where S is the signal and B the background count rates, particularly from fluctuations in man-made background. (auth)

24862 ACCURACY OF APPROXIMATE SOLUTIONS FOR CURRENTS IN A PLANE PARALLEL ION CHAMBER. W. Armstrong and P. A. Tate (Defence Chemical Biological and Radiation Labs., Ottawa). Phys. Med. Biol., 10: 229-41(Apr. 1965).

A computer solution was obtained for Thomson's equations for the electric field in a uniformly irradiated ion chamber. Results for the current-voltage relationship agree closely with those calculated by the approximate methods of Mie. In particular, Mie's formula for the nearly

saturated region was confirmed for degrees of saturation of 70% and above. The formula derived by Boag and Wilson for this region is shown to hold only for degrees of saturation above 95%. This confirms experimental results previously obtained with practical chambers. (auth)

24863 200 SAMPLE-CHANGER LIQUID SCINTILLATION COUNTER WITH CHANNEL-RATIO COMPUTER. H. Miwa, I. Morita, T. Kasai, U. Yamamoto, J. Horio, N. Hino, and U. Asayama (Kobe Kogyo Corp., Japan). Radioisotopes (Tokyo), 14: 126-31(Mar. 1965). (In Japanese)

The 200 sample-changer liquid scintillation counter with the channel-ratio computer is described. The device is constructed with an automatic sample-changer for 200 samples, a pulse-height analyzer, and an automatic counting system. The sample changer, providing a freezer and fitting a special mechanism, is rather compact, moreover, it can reserve numbers of sample. The detecting probe could be improved S/N ratio by means of the current mode connection method. The pulse-height analyzer has the transistorized circuit and the invented graphic panel, which makes it very convenient to operate. The counting system is fully automatic; it can compute the channel ratio for the counting efficiency, and record the results. The number of channels can be selected from one to three channels. (auth)

24864 LIQUID SCINTILLATOR DECAY TIME MEASUREMENTS IN THE SUB-NANOSECOND RANGE. Yves Koechlin. Trans. N. Y. Acad. Sci., 27: 227-35(Dec. 1964).

Studies were made of the shape of the scintillation light pulse. Special emphasis on the early part, which was measured in the sub-nanosecond range. Single photon timing possibility is discussed. The pulse shape was obtained from the distribution of individual photons using the standard coincidence technique. The scintillator is visible to two photomultipliers (PM); when a scintillation occurs, the first PM receives as much light as possible and the output pulse provides a mean emission time for the scintillation with a 0.1 nsec precision. The second PM is placed much farther from the scintillator, and a small slit in front of the photocathode is adjusted in such a manner that the photocathode cannot emit more than one photoelectron when a scintillation occurs. The corresponding output pulse determines the emission time of this photoelectron with ±0.3 nsec precision. The distribution curves obtained using a stilbene crystal in place of the liquid scintillator and using 6 g/l p-terphenyl in toluene are shown. The response function of the apparatus was determined. (M.C.G.)

24865 PARTICLE DISCRIMINATION AND LOADING TECHNIQUES FOR NUCLEAR EMULSIONS. Hervasio G. de Carvalho (Centro Brasileiro de Pesquisas, Rio de Janeiro). p.247-319 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965.

Methods for particle discrimination and for loading of nuclear emulsions with particular elements are reviewed, after a discussion of development, fog, fading, and solarization with emphasis on selection of the best developing solution and processing conditions. 125 references. (D.C.W.)

24866 THE DEVELOPMENT OF SPARK CHAMBER TECHNIQUES. G. Charpak (CERN, Geneva), L. Massonnet, and J. Favier. p.321-84 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965.

After a brief review of some mechanisms of gaseous amplification and breakdown, the factors influencing the characteristics of small-gap spark chambers are discussed; and a survey of the field under active development is presented, including chambers using gaseous amplification to obtain better tracks and filmless techniques for data acquisition. 96 references. (D.C.W.)

24867 COUNTER DIODES AND COUNTER TRANSISTORS. Werner Czulius (Siemens-Schuckertwerke AG, Erlangen, Ger.). p.216-44 of ["Vortrag aud der Halbleiter-Tagung in Saarbrucken am 5. IV. 1962, Erischienen in Festkorperprobleme Band 2."] Brunswick, Verlag Vieweg, 1963. (In German)

A bibliographic review is given of the most important properties and applications of counter diodes and counter transistors. (J.S.R.)

24868 THE SCINTILLATION OF LIQUID HELIUM. Frank Edward Moss. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 76p.

The pulse height spectra from scintillations induced in liquid helium by ^{210}Po alpha and ^{137}Cs beta particles were observed as a function of temperature in the range from 4.2° to 1.3°K. The scintillation light in the case of the alpha particles is inhibited by about 8% at 1.3°K as compared to its value at the lambda point (2.18°K). This inhibition, which is very sharp immediately below the lambda point, is attributable to the superfluidity of the liquid, and is a new superfluid effect not previously observed. By contrast, the scintillation light from beta irradiation of the liquid does not indicate a strong functional dependence on the temperature below the lambda point. (Dissertation Abstr., 25: No. 6, Dec. 1964).

24869 AUTOMATIC ABSORPTION COUNTER /Q-1314/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). 13 drawings. (CAPE-917)

An absorption counter used in radiochemistry to obtain the K curves of mixed beta emitters and for gamma counting is described. It is reliable and counts on a given cycle. A G-M tube and a 64 Scaler are used with the counter. The counter housing is shielded by 0.25 in. of lead. The absorption curves are used to determine what is decaying. The absorber is fabricated of Al. (For details, see TID-4100). (D.C.W.)

24870 MULTICHANNEL SPECTROMETER FOR THE MEASUREMENT OF TRAPPED PARTICLES. J. B. Reagan, J. C. Bakke, W. L. Imhof, and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). 16p. (CONF-799-15)

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

A spectrometer was designed to measure in detail the energy spectrum and omnidirectional flux of energetic charged particles encountered in low-altitude satellite orbits. Two versions of the instrument are described. Each detects particles in a solid angle which approaches 2π steradians and utilizes a plastic scintillator and photomultiplier combination. In each case the energy spectrum is obtained from a pulse-height analyzer having 16 channels. The first version of the instrument employs a single plastic scintillator which is shielded, except for a 2.54-cm-diameter opening, and which provides sufficient path length to stop electrons and unambiguously determine their energy to 5 Mev. The analyzer is programmed in two ranges corresponding to electron energies of 0.28 to 2.61 and 0.28 to 10.02 Mev. Electron spectra obtained from this instrument on a low-altitude satellite are included. The second version of the instrument has an additional anticoincidence scintillator surrounding the entire detection crystal except for the entrance aperture, thus eliminating the contribution from all particles which do not enter via the aperture and stop in the center scintillator. In addition, shielding surrounds the outer scintillator to limit the anticoincidence dead time. The energy ranges are expanded in order to obtain fluxes and spectra of electrons from 0.3 to 7.0 Mev and protons from 12 to 80 Mev. This latter instrument is scheduled for use on the manned Gemini vehicles. (auth)

24871 APPARATUS SUITABLE FOR USE IN DETERMINING NEUTRON FLUX DISTRIBUTION. Colin Campbell McCormick, David Kendall Cartwright, and James Alan McKnight (to United Kingdom Atomic Energy Authority). British Patent 968,048. Aug. 26, 1964. Filed Sept. 12, 1962.

A flux scanning apparatus suitable for determining neutron flux distribution in a nuclear reactor is made up of a flexible train of containers dimensioned for insertion into a reactor core channel. Each container is adapted to house

a separate flux sampling element and preferably is of cylindrical form having an eccentric bore for passage of the flexible carrier member. The carrier member is preferably in the form of a rod or tube and supports in juxtaposition a fixed plug and a rotatable body having a storage hole. The body is rotatable from a position allowing access to the hole to a position in which the hole is closed by the plug. A tubular guide member into which the assembly can be inserted is of a size permitting axial movement of the assembly while preventing rotation of the body to a position allowing access to the hole. (B.L.M.)

24872 DEVICES FOR MEASURING NUCLEAR RADIATION ENERGIES. (to Harshaw Chemical Co.). British Patent 968,188. Aug. 26, 1964. Priority date Sept. 4, 1959, United States.

A scintillometer is described that contains its own reference standard in the form of a second luminophore located in a cavity in a first luminophore. Both luminophores are organic phosphors, and the second is shielded from the first by means of a light transparent organic material such as an epoxy resin coating of a thickness sufficient to stop α particles. The second luminophore contains an α emitting radioactive material disposed therein, and the preferred reference luminophore is a Th activated NaI scintillation crystal. The first luminophore is coupled to a photomultiplier tube. (B.L.M.)

24873 ARRANGEMENT FOR DETERMINING RADIATION. Lothar Schwaar (to VEB Vakutronik). British Patent 968,189. Aug. 26, 1964. Filed Sept. 15, 1960.

An apparatus is provided by which an accurate determination of the dose or dosage performance (dose per unit of time) of radiation, preferably β or γ radiation, of unknown energy spectrum can be made. An absorber is inserted in front of the radiation detector, which may be a counting tube, scintillation counter, or solid-body detector. The absorber has a varying resistance to the passage of low-energy radiation over a large part of the detector and obstructs the passage of high energy radiation over a smaller part of the tube. The difference between particle density measured with and without the absorber is proportional to the dosage performance of the radiation. (B.L.M.)

24874 APPARATUS FOR MEASURING THE ENERGIES OF NEUTRONS. (to Kernforschungsanlage Julich des Landes Nordrheinwestfalen-e.V.). British Patent 978,209. Dec. 16, 1964. Priority date Dec. 6, 1962, Germany.

An apparatus for measuring the energies of neutrons comprises a detector, a moderator surrounding the detector, and a threshold neutron absorber disposed between the detector and moderator. The neutron detector is a counting tube filled with BF_3, the moderator is a paraffin block with the surrounding surface coated with a 0.5-mm Cd layer, and the absorber is a Cd sleeve having a wall thickness of about 1 mm. The sleeve absorbs all those neutrons with an energy less than 0.4 ev from the neutrons converted by the moderator. Two different values are indicated when measurements are effected with and without the sleeve, and the ratio of the values is dependent upon the average energy of the neutrons impinging upon the apparatus. (B.L.M.)

24875 SCINTILLATION SCANNER PHOTO-CIRCUIT. Joseph B. Stickney, Carl E. Herring, and Walter E. Splain (to Picker X-Ray Corp.). U. S. Patent 3,159,744. Dec. 1, 1964. Filed Feb. 6, 1963.

A photorecording system responsive to radioactivity detected by a scintillation scanning device is described in which the light pulse output varies both in frequency and intensity with the count rate. The device employs a cathode ray tube as a light source and a novel system for transmitting impulses from the scintillation probe to the tube. The density of the photographic image produced is proportional to the detected count rate. The image produced by the recording system reflects each impulse emitted by the probe in response to detected activity. Also, there is no time delay provided in the system so the cathode-ray tube emits a light pulse substantially instantaneously after the probe detects a measurable radioactive particle or ray. (B.L.M.)

24876 FAIL PROOF RADIATION MONITOR AND ALARM CIRCUIT. Wallace Jones (to Nuclear Materials and Equipment Corp.). U. S. Patent 3,159,747. Dec. 1, 1964. Filed Jan. 12, 1960.

The invention relates to a device for the detection and signaling of the existence of an abnormality in a monitored region. The device is particularly applicable to the detection of radioactivity and includes the usual pick-up element such as a Geiger-Mueller counter; but the alarm device is applicable to detection in general, for example to burglar alarms. The counter produces current pulses in response to the incidence of radiation. The pulses are integrated and if repeated at a critical rate actuate a luminescent element having a critical break-down voltage. The luminescent element actuates photosensitive means that set off the main alarm. The device is jam-proof, has a relatively long life in service, and embodies facilities for self-testing without disorganization of or discomfort to personnel. (B.L.M.)

24877 NUCLEAR RADIATION MEASURING SYSTEM UTILIZING A RADIO RECEIVER. Robert M. Kiehn. U. S. Patent 3,160,750. Dec. 8, 1964. Filed Dec. 8, 1964.

A radiation ratemeter device is patented for use with an ordinary AM radio receiver to enable radiation intensity to be indicated by the frequency scale on the radio receiver when the tuning knob is turned to such a position that a certain tell-tale tone signal is produced. The device employs a radiation-sensing cell, such as a CdS photocell screened from light, of high resistance at low radiation intensity and whose resistance is inversely proportional to radiation intensity. A semiconductor, variable capacitance, junction diode and connections are provided for varying the voltage across the diode in response to changes in resistance of the sensing cell. A tuned oscillator circuit generates an r-f carrier whose frequency is determined by the capacitance of the diode; and a tone modulator system, which may include at least most of the oscillator circuit, produces a tone-modulated signal having a frequency in the range of 550 to 1700 kc. (B.L.M.)

24878 SAMPLE-CONVEYING AND LIGHT-SEALING MECHANISM FOR SCINTILLATION COUNTING. Raymond L. Meeder and Joseph E. Kus (to Nuclear-Chicago Corp.). U. S. Patent 3,163,756. Dec. 29, 1964. Filed Apr. 3, 1962.

An automatic device for exposing liquid scintillation samples to highly sensitive photomultipliers includes a chamber, a light-responsive detector within the chamber, and an elevator ram assembly for moving samples into and out of the chamber. An elongated vertical passage connects the chamber with an aperture above the chamber. A sample holder movable through the passage has a resilient seal extending between the outer surface of the holder and the inner surface of the passage in light-tight sliding engagement. A shutter in the passage blocks exterior light when the sample holder is in the chamber below the passage. Automatic means are provided for operating the shutter as the sample moves along the passage and for positioning the sample in the chamber. (A.G.W.)

24879 ELECTROCHEMICAL DOSIMETER. S. Z. Lewin and R. H. Koslow (to U. S. Atomic Energy Commission). U. S. Patent 3,179,581. Apr. 20, 1965.

A quantitative and qualitative electrochemical dosimeter is described. It has two separate liquid electrolytic solutions interconnected through a porous frit; one consists of 10^{-3} M ferrous sulfate in 0.8N sulfuric acid and the other of 0.8N sulfuric acid. A gold anode is immersed in the ferrous solution and a platinum cathode in the other solution. External current measuring means are connected to the cathode and the anode. Depolarizing means are connected to the cathode to repolarize the cathode on exposure of the solutions to radiation. (AEC)

Radiation Effects

Refer also to abstract 25754.

24880 (BMI-X-10120) IRRADIATION OF SNAP SYSTEM ELECTRICAL DEVICES IN A HIGH-TEMPERATURE

VACUUM ENVIRONMENT. Sam J. Basham, William J. Zielenbach, H. Thomas Gruber, and Joseph P. Allgeier (Battelle Memorial Inst., Columbus, Ohio). Apr. 5, 1965. Contract W-7405-eng-92. 48p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A series of electrical devices was exposed to an integrated fast-neutron exposure of about 5 to 8×10^{18} n/cm^2 in a high-vacuum environment (<10^{-6} torr) with specimen temperatures maintained at specified levels in the 650 to 1050°F range to obtain radiation-effects data for the Atomics International SNAP program. Two separate experiments were conducted; 12 specimens were exposed in the first (Experiment HF-6) and 16 in the second (Experiment HF-7). Nuclear environments were measured by extensive dosimetry. The electrical characteristics of the specimens were measured during the irradiation. These data were transmitted to Atomics International for use in SNAP program systems development. (auth)

24881 (GA-4395) NUCLEAR RADIATION EFFECTS IN AN IMPACT DETECTOR, TRIGGER CIRCUIT, AND DC AMPLIFIER. Final Report. R. F. Overmyer, R. A. Poll and V. A. J. van Lint (General Atomic, San Diego, Calif.). July 10, 1963. For Avco Corp., Wilmington, Mass. Research and Advanced Development Div. Contracts 108387 and AF04(694)-239. 89p. (RAD-SR-63-159)

A piezoelectric impact detector and associated gas tube firing circuit was investigated for its susceptibility to an intense pulse of ionizing nuclear radiation. The circuit consists of a piezoelectric impact detector crystal connected by a coaxial cable to a firing circuit. The firing circuit is in two stages—the detector pulse breaks down a gas diode which applies a pulse to the grid of a gas triode; the charge stored in the capacitor is then discharged through the triode into the load. The test program was aimed at predicting the response of this circuit to intense nuclear pulses, up to and including a pulse 0.1 μsec long having a peak ionization rate of 10^{11} Rad/sec. Experimental and theoretical analyses of the circuit indicated that the component of the circuit most sensitive to a radiation pulse is the gas triode which fires when the radiation pulse exceeds a threshold dose. The response of a transistorized IDS Mod 2-19 d-c amplifier to high-intensity radiation was also investigated with spot beam dose rates of 10^{11} Rad/sec and overall dose rates of 4×10^9 Rad/sec. The doses delivered to the amplifier ranged from 10^3 Rad/0.1 μsec over the area of the amplifier to 2×10^5 Rads over an area of one cm in 4.5 μsec. The amplifier operation remained unaffected after receiving a total dose of 3×10^{14} electrons/cm^2 during the experimental work. The output of the amplifier was observed as were several points in the circuit during and after pulses of 30-Mev electrons. With a dose of 4×10^3 Rads delivered in 1 μsec, transient spikes of about 3 v, lasting for 0.5 msec, were present. The d-c output dropped to zero for about 1 msec and then recovered rapidly to its normal d-c output level; however, an increased ripple amplitude persisted for about 10 msec longer. The increased ripple was correlated with a d-c shift in the amplification stages which was modulated by the operation of the demodulation circuit. The total transient effect in the output covered a period of approximately 15 msec. Spot beam doses to portions of the amplifier caused the output to remain at zero for longer periods of up to 15 msec; however, the output returned to normal in only a few msec more. The transistors and the Zener diode were irradiated separately in the unscattered electron beam at 10^{11} Rad/sec with pulses of 0.1 μsec and 4.5 μsec. Only the IDS 1284 transistor showed a significant change in operation with 4×10^4 Rad per pulse, and this did not appear to affect the amplifier operation noticeably. A Sprague 150D capacitor was chosen as a representative type and was separately irradiated in the spot beam to obtain information on the charge motion through the dielectric. Several large value capacitors are used in the circuit where they have long recharging times. This tends to lengthen the recovery time at the output after a pulse of radiation lowers their voltages due to transient conductivity in the dielectric. (P.C.H.)

24882 (LA-DC-7108) RADIATION DAMAGE TO THE SCINTILLATION PROPERTIES OF LITHIUM IODIDE CRYSTALS. (thesis). Dale E. Hankins (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 84p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Submitted to Kansas Univ., Lawrence.

LiI crystals similar to those used in neutron-survey instruments were irradiated in the Water Boiler reactor with a thermal-neutron flux of 2.9×10^{12} n/cm^2. The irradiations changed the color of the crystals and their scintillation properties in the following manner: (1) The light output for neutrons was decreased. (2) The percent resolution of the neutron peak became larger. (3) The light output of the crystals for gamma rays also was decreased. There is a broadening of the gamma-ray spectra similar to that noted for the neutron peak which, when combined with (2), eventually caused the neutron peak and the gamma-ray pulse-height spectra to overlap. During a period of about a month, following irradiation, the crystals recovered from radiation damage; after a month, the scintillation properties rapidly deteriorated. The effects of radiation damage on crystals used in monitoring instruments, and the dose to which an instrument would have to be exposed to cause radiation damage to the crystal, are discussed. A brief study was made of the recovery of these crystals from radiation damage by annealing with light and heat. A study was also made of the changes in the scintillation properties of these crystals because of aging and the necessary adjustments to the electronic systems of neutron-survey instruments to compensate for these changes. (auth)

24883 (NAA-SR-10284) LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRONIC COMPONENTS (BMI-LF-2). M. N. Robinson, S. G. Kimble, N. F. Davies, and D. M. Walker (Atomics International, Canoga Park, Calif.). Apr. 20, 1965. Contract AT-11-1-GEN-8. Dep.; $4.00(cy), 3(mn) CFSTI.

The second of a series of irradiation experiments on electronic devices intended for SNAP reactor control systems is described. Several diode and transistor types, sensistors, capacitors, and an oscillator from a prototype SNAP 10A Startup Controller were irradiated to 3×10^{15} nvt (>0.1 Mev) and 5×10^8 R (gamma) at the Battelle Memorial Institute Research Reactor. Results are presented of in-pile measurements of the critical electrical characteristics, in the form of graphs produced automatically by a computer peripheral plotting facility. (auth)

24884 (SC-TM-261-63(14)) DEGRADATION OF NPN SILICON PLANAR TRANSISTORS WITH BOMBARDMENT BY HIGH-ENERGY NEUTRONS. J. A. Hood (Sandia Corp., Albuquerque, N. Mex.). Oct. 1963. Contract [AT(29-1)-789]. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

To determine the effects of high-energy neutron irradiation on transistor circuits, it is necessary to know the degradation of the transistor's characteristics with the neutron dosage. The transistor parameter most affected is the current gain. A description is given of the loss of gain which occurs and a testing technique which, with the use of empirical data, predicts the gain after the neutron irradiation. (auth)

ISOTOPE TECHNOLOGY

Industrial Applications

Refer also to abstract 24909.

24885 (TID-21405) EFFECTS OF IONIZING RADIATION ON LIPIDS OF FISH. Final Report, November 1963–November 1964. Maurice E. Stansby and George Kudo (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Nov. 1964. Contract AT(49-11)-2058. 33p. Dep.; $2.00(cy), 1(mn) CFSTI.

An investigation was made of problems related to changes caused by irradiation at 0.3 megarads of lipids and associated pigments in eight species of fish ranging in lipid content from 5 to 20 percent. Samples were irradiated and subsequently stored at 33°F, after being packaged both in evacuated tin cans and in sealed mylar-polyethylene pouches. Changes in the fish, immediately after irradiation and after storage for periods up to 6 weeks, were measured by use of an experienced sensory panel and, in some cases, by determining the peroxide number of the lipid after extraction from the fish. The quality of the samples was compared against that of two controls. One control was unirradiated, frozen, and stored at −20°F and the other unirradiated control was stored in polyethylene pouches at 33°F to simulate normal commercially handled iced fish. Five species of salmon, rainbow trout, herring, and sablefish were used in this work. Although there was considerable difference among species in susceptibility to lipid changes, all of the species showed a combination of adverse changes that more than neutralized any advantages of retardation of bacterial spoilage by the irradiation process. Samples irradiated and stored in the polyethylene pouches in the presence of air showed extreme adverse changes. Those samples that were vacuum packed showed much less development of rancidity, but loss of normal color and loss of natural flavor was still very marked. (auth)

24886 RADIOISOTOPIC TECHNIQUE IN LITHUANIAN SSR. S. Gechyauskas and K. Valatska. At. Energ. (USSR), 18: 310-11(Mar. 1965). (In Russian)

Applications of radioisotopes in medical and physics research laboratories and industry are discussed. (R.V.J.)

24887 THE EVALUATION OF SCRUBBING TESTS ON TEXTILE SURFACES USING β-RADIATION. A. Heger. Faserforsch. Textiltech., 15: 126-7(Mar. 1964). (In German)

The evaluation of scrubbing tests on textiles can be carried out by measuring the weight deficit or strength loss or by counting the scrubbing movement up to the visible destruction of the cloth, but these methods do not indicate the distribution of the scrubbing effect over the area investigated. By means of β absorption, exact data on the surface distribution intensities can be established. ^{85}Kr and ^{90}Sr/^{90}Y are the most suitable radiation sources for textiles with 50 to 600 g/m^2 area densities. A Geiger counter should be used as the radiation detector. The procedure for carrying out these scrubbing tests is described. From the absorption equation, $I = I_0 e^{-\mu F}$, where F is the area mass, the mass defect, MV, can be determined before and after scrubbing from the relation, MV = [FM(before)-FM(after)/FM(before)] 100%. (OID)

24888 RADIOACTIVE LABELLING AS A TECHNIQUE FOR STUDYING THE MIXING PROCESS OF THE COMPONENTS IN TECHNOLOGICAL COAL PRODUCTION. K. Wagner, J. Legler, R. Mueller, and W. Huth (Institut fur Physikalische Chemie, Deutsche Akademie, Berlin and VEB Elektrokohle Lichtenberg, Berlin). Kernenergie, 8: 185-90(Mar. 1965). (In German)

Before mixing the hard components (granular coke) and the adhesive (pitch) in artificial coal production, the pitch was mixed with benzoate labeled with radioactive ^{24}Na. The time behavior of the mixing process was studied by sampling and activity measurement. The studies were carried out on laboratory scale by means of a 2 liter and a 10 liter mixer, later on in the electrode factory by means of a 2000 liter mixer. Moreover, the possibility of applying radioautographic technique for determining the labeled component distribution in the mixture was investigated. (auth)

24889 HOW TO COMPUTE ABSORPTION AND BACKSCATTERING OF BETA RAYS. [C. W. Tittle]. Nucl.-Chicago Tech. Bull., No. 8, 3p.

The use of beta transmission or scattering to measure the thickness of thin sheets or coatings, to probe a small structure containing materials of contrasting atomic number, or to determine the composition of binary mixtures is considered. Methods are described for determining the feasibility of such applications and the required stability of the detector system. The energy spectrum and range of beta particles, their absorption, and backscattering are discussed. A semi-empirical theory of beta backscattering is presented. (M.C.G.)

24890 HOW TO COMPUTE ABSORPTION AND BACKSCATTERING OF GAMMA RAYS. [C. W. Tittle]. Nucl.-Chicago Tech. Bull., No. 9, 4p.

A procedure for estimating gamma backscattering is described. The information given may be used in first engineering estimates of the feasibility of proposed applications of gamma transmission or backscattering. Fundamental interactions of gamma rays with matter, the Compton effect, the photoelectric effect, pair production, the total attenuation coefficient, buildup factors, and backscattering are discussed. (M.C.G.)

24891 THE EFFECTS OF Co^{60} γ-RAYS ON FRIED BEAN CURD. X. THE EFFECTS OF BEAN CURD PROTEINS AND A PHOSPHORUS COMPOUND ON THE OIL EXTRACTED FROM THE MEAT OF FRIED BEAN CURD. C. Urakami, Y. Nishijima, and T. Yamanishi. Osaka Shiritsu Daigaku Kaseigakubu Kiyo, 11: 15-25(Mar. 1964). (In Japanese)

As a preliminary step in controlling the off-odor of irradiated fried bean curds, an attempt was made to correlate it with various analytical values used for rancid or oxidized fats. Oil fraction samples from meat containing 10 and 50% bean curd proteins and 0.1% phosphoryl-ethanolamine were irradiated with a ^{60}Co source up to a total dose of 4.8×10^5R at 1×10^4 R/hr either at ice-cooling temperature or at room temperature (11.8 to 18.9°C). Each sample was analyzed for its peroxide, volatile acid, and volatile carbonyl values and examined by an uv absorption spectrophotometer. The hydrazones of the volatile carbonyl compounds were separated by column and paper chromatographic techniques to find detectable numbers of the compounds. Although the sour odor could not be differentiated in the samples, significant differences were found in the analytical results. In general, the samples irradiated under ice-cooling were oxidized less than those irradiated at room temperatures. (OID)

24892 STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENTS COMPONENTS BY GAMMA-RAY IRRADIATION. III. EFFECTS ON THE SOYBEAN. Seiko Okanoue (Hiroshima Univ.), Matsue Fukutani, Mizuho Sugihara, and Isao Hashida. Radioisotopes (Tokyo), 14: 89-92(Mar. 1965). (In Japanese)

The optimum dose of gamma irradiation for preventing mold growth and vermin damage on soybeans was studied. Soybeans were irradiated by cobalt-60 gamma rays at doses from 0.05×10^4 to 100.0×10^4 R in about $\frac{1}{7}$ mm thick polyethylene film bags in the presence of air or nitrogen. After irradiation, samples were stored at room temperature for about 18 months. Outward appearances, tastes, and contents of main nutrient components were estimated. Irradiation at a dose of more than 10.0×10^4 R in air was

effective for keeping soybeans from getting moldy, but, on the contrary, irradiation of about 1.0×10^4 R accelerated the mold growing. In nitrogen atmosphere, dose of 1.0×10^4 R gave better results in comparison with controls. The boiled states and the tastes of the samples were almost unchanged by irradiation at these doses. The main nutrient components were also unchanged by irradiation. No blight was found in the storage period. For the preservation of soybeans it was found desirable to irradiate with gamma rays at a dose of 10.0×10^4 R in air or 1.0×10^4 R in nitrogen atmosphere. (P.C.H.)

24893 STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENTS COMPONENTS BY GAMMA-RAY IRRADIATION. IV. EFFECTS ON THE RED BEAN. Seiko Okanoue (Hiroshima Univ.), Matsue Fukutani, Mizuho Sugihara, and Isao Hashida. Radioisotopes (Tokyo), 14: 93-5(Mar. 1965). (In Japanese)

Studies were made on the prevention of mold growth and vermin damage on red beans by gamma irradiation. The optimum dose was determined. Red beans were irradiated by cobalt-60 gamma rays at a dose of from 0.05×10^4 to 100.0×10^4 R in about $\frac{1}{7}$ mm thick polyethylene film bags. Atmosphere was air or nitrogen. After irradiation, samples were stored at room temperature for 30 months. Outward appearances, tastes, and contents of fats were estimated. Immediately after irradiation, outward appearances remained unchanged. Irradiation at a dose of 1.0×10^4 R could not keep red beans from getting moldy, but, irradiation at 10.0×10^4 to 100.0×10^4 R was effective in suppressing the mold growth. A higher dose was even more effective. The boiled states and the tastes of the samples were equally good as compared to the control in every case. The contents and the characteristic properties of the fats were almost unchanged by gamma irradiation. Vermin were not found during storage. Therefore it was desirable to irradiate red beans that contained fats in small quantities and carbohydrates in large quantities at a dose of 10×10^4 to 100×10^4 R in air. Good results were not obtained by irradiation of the red beans in nitrogen atmosphere as in the case of soybeans. (P.C.H.)

24894 STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENTS COMPONENTS BY GAMMA-RAY IRRADIATION. V. EFFECTS ON THE RICE. Seiko Okanoue (Hiroshima Univ.), Matsue Fukutani, Mizuho Sugihara, and Isao Hashida. Radioisotopes (Tokyo), 14: 97-102(Mar. 1965). (In Japanese)

The prevention of mold growth and vermin damage on rice by gamma irradiation was studied. Rice was irradiated by cobalt-60 gamma rays at a dose of 0.5×10^4 to 400.0×10^4 R in about $\frac{1}{7}$ mm thick polyethylene film bags in an atmosphere of air or nitrogen. After irradiation, samples were stored at room temperature for 18 months. Outward appearances, tastes, and changes in nutrient components were estimated. Relations between irradiation doses and these factors were investigated and the optimum dose was determined. Irradiation at a dose of more than 40.0×10^4 R caused the coloration of yellowish brown and its density increased with irradiation dose. Vermin did not grow when irradiated at a dose of more than 4.0×10^4 R. Irradiation at 40.0×10^4 R could keep the rice from getting moldy and prevent the vermin damage. In nitrogen atmosphere results were better in some degree. When irradiated at less than 4.0×10^4 R, taste of the boiled rice was good, but over 40.0×10^4 R, the boiled rice was not fit for eating and after 6 months' storage this difference became quite remarkable. Effects of irradiation on the contents of water and fats were not recognized. Acid value was most changeable by irradiation and more increased in the polished rice than in the unpolished one. The specific gravity, refractive index, saponification value, and iodine number were almost unchanged until 6 months later, but after 18 months' storage, the acid value increased and both the refractive index and the iodine number decreased with the irradiation dose. These changes were also more remarkable in the polished rice than in the unpolished one. It was concluded that for the preservation of rice, it is preferable to irradiate at a dose of 10.0×10^4 R on unhulled rice and polish it before cooking. (P.C.H.)

24895 STUDIES ON THE PRESERVATION OF FOODS AND THE CHANGES OF THEIR NUTRIENTS COMPONENTS BY GAMMA-RAY IRRADIATION. VI. EFFECTS ON THE SWEET POTATO. Seiko Okanoue (Hiroshima Univ.), Matsue Fukutani, Mizuho Sugihara, and Isao Hashida. Radioisotopes (Tokyo), 14: 103-10(Mar. 1965). (In Japanese)

Optimum conditions in the radiosterilization of sweet potatoes were determined. After irradiation at 0.25×10^4 to 150.0×10^4 R samples were stored in a temperature and moisture controlled room for 4 ~ 9 months. Outward appearances, germination, tastes, weights, contents of water, and vitamin B_1, B_2, and C were estimated. The necessary dose for germination control was found to be 1.2×10R just after harvest and 0.8×10^4R just before planting. Generally, the weight changes in the storage period were not influenced by low irradiation doses and were rather small at 1.2×10^4 R, but over this dose the weights decreased rapidly with increase of irradiation dose. Immediately after irradiation, samples irradiated at less than 5.0×10^4 R were good to eat, but after 4 months storage this value decreased to 1.2×10^4R. Immediately after irradiation, water contents were not influenced by irradiation, but during storage these values were rapidly decreased with increase of irradiation dose. Vitamin B_1 contents were decreased in small quantities by irradiation at doses below 20.0×10^4R. At 20.0×10^4R vitamin B_2 contents were not influenced and vitamin C contents were unchanged. Irradiation under 1.2×10^4R did not cause any appreciable change in outward appearances, tastes, or vitamin contents as compared with the controls. (P.C.H.)

24896 DENSITY AND CONCENTRATION MEASUREMENTS BASED ON THE MATERIAL INTERACTIONS OF NUCLEAR RADIATIONS. I. A RADIOISOTOPIC METHOD FOR MEASURING THE DENSITY OF SOLUTIONS USING A SCINTILLATION DETECTOR. E. Hazi, Z. Csapo, and B. Jelinko. Veszpremi Vegyip. Egyet. Kozlemen., 7: 145-62 (1963). (In Hungarian)

^{51}Cr, ^{137}Cs, and ^{60}Co (0.3 to 1.5 Mev) were used in density measurements of aqueous solutions of $MgCl_2$. A scintillation detector with a photomultiplier and a decade counter and later a ratemeter were also used. The value of the mass absorption coefficient calculated for the 3 isotopes and compared with the theoretical value varied with the density of the sample and differed from the theoretical value. The optimal radiation source for measuring densities of materials of a lower order [atomic no.] was a 30-mm diam $^{137}CsCl$(1.5 mC)-coated flat disk. The sample container should be a cylindrical iron tube or pipe (for flowing solutions) with a 15-cm inner dia and 1- to 10-mm thick wall. Maximum sensitivity was obtained with a 30-mm deep cone-shaped collimator, which directed the radiation toward the detector at 0 discriminator voltage using a 3-mm Pb filter. A stabilizing tube was used to produce a voltage difference for reference and compensation. (OID)

24897 DENSITY AND CONCENTRATION MEASUREMENTS BASED ON MATERIAL INTERACTIONS OF NUCLEAR RADIATIONS. II. CONTINUOUS DENSITY MEASUREMENT OF COAL AND ROCK SLURRIES BY γ-RAY ABSORPTION. E. Hazi, Z. Csapo, and B. Jelinko. Veszpremi Vegyip. Egyet. Kozlemen., 7: 163-9(1963). (In Hungarian)

A ^{137}Cs source and a scintillation detector were used for the continuous measurement of the density of coal and rock slurries (1.2 to 1.4 g/cc density) flowing in steel pipes (150 mm in dia, 6-mm-thick walls) at about 4 m/sec in a process for separating the coal from the rocks. With the exception of Pb and W the main component elements and a considerable part of the trace elements in the rock slurry had atomic numbers below 30 and their mass absorption coefficients fell within the μ interval. Therefore, the Compton region of energy could be used for the density determination. Control determinations were made by weighing the samples. Differences between the data obtained radiometrically and by weighing were due to the fact that in one case static density is measured while in the other the dynamic density is measured. The differences were larger when the density of the slurry was greater and smaller when the size of the particles was smaller. The radio-

metric method was calibrated to measure the dynamic density. (OID)

24898 DENSITY AND CONCENTRATION MEASUREMENTS BASED ON MATERIAL INTERACTIONS OF NUCLEAR RADIATIONS. III. CONTINUOUS RADIOMETRIC DENSITY MEASURING APPARATUS APPLICABLE IN FACTORIES. E. Hazi, Z. Csapo, and B. Jelinko. Veszpremi Vegyip. Egyet. Kozlemen., 7: 171-80(1963).

A device with a ^{137}CsCl source was constructed for measuring the density of solutions and slurries transported in pipes. The radiation was measured with a scintillation detector containing a photomultiplier. A calibrating absorbent wedge with a scale was used to determine the wear in the pipes caused by slurries or corrosive materials moving through them. A modified ratemeter was the basic device in the electronic unit. A very sensitive compensating circuit measured the voltage changes due to changes in the density of the measured material. The source and the detector were placed in a protective box, which was heat-insulated and air-tight. (OID)

24899 FOOD PRESERVATION BY IRRADIATION. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Apr. 1963. 8p. SB-403(Suppl. 1). $0.10(CFSTI)

Forty-six references are given to literature on the radiation processing of food and related subjects. (C.H.)

24900 KATALOG PRIBORY, DEISTVIE KOTORYKH OSNOVANA NA ISPOL'ZOVANII ISTOCHNIKOV YADERNYKH IZLUCHENII, DLYA KONTROLYA I AVTOMATIZATSII TEKHNOLOGICHESKIKH PROTSESSOV, POSTAVLYAEMYE VSESOYUZNYM OB'EDINENIEM "IZOTOP" V 1965. (Catalog of Instruments Using Nuclear Sources and Utilized for Controlling and Automation of Technological Processes, produced by the All-Union Group, "Isotope" 1965). Moscow, Atomizdat, 1964. 58p.

Descriptions are given of various radioisotopic instruments and devices manufactured in the USSR. The list includes various gamma-relays, level gages, thickness and density gages, gamma industrial units, neutron moisture index apparatus, and various others still under construction or in a design stage. (R.V.J.)

24901 AMERICIUM-241 AS A NON-DESTRUCTIVE TESTING TOOL FOR THE AIRCRAFT AND SPACE INDUSTRY. Gordon Locher. 9p. (CONF-641017-9)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

Panoramic radiography was carried out at source-film distances as low as $\frac{1}{8}$ in., using a long, thin ^{241}Am gamma source, inside steel tubes up to 0.100 in. thick. Penetrameter sensitivity of 2% and unsharpness values as low as 0.002 in. were obtained. There was no geometrical distortion of radiographs. A special exposure device was developed to do this work. It somewhat resembles a circular Potter-Bucky diaphragm surrounding the line source of gamma rays. Double-wall radiography was carried out on small tubing at source-film distance of 1.5 to 2.0 in. in another crowded-component application, using devices resembling a fountain pen $\frac{3}{8}$ in. OD in size and shape. ^{241}Am sources used ranged from 20 (1 mm focal spot) to 50 (1.5 mm) to 150 mC (2.0 mm). Simultaneous use of many units is expected, to speed radiographic output. Transmission type thickness gages were used with ^{241}Am sources up to 100 mC to gage steel up to 0.100 in. thick with a sensitivity of 0.0001 in. These replace high-energy beta sources formerly used. Applied to measurement of concentricity of seamless tubing, uniformity of wall thickness, and a host of other problems in military and aerospace industries, they proved their worth for special and for routine inspections. (auth)

Power Application

24902 (BNWL-51) NONDESTRUCTIVE TESTING OF ISOTOPE HEAT SOURCES. Interim Report. R. W. Steffens, D. R. Green, and G. F. Garlick (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1965. Contract AT(45-1)-1830. 29p. Dep.; $2.00(cy), 1(mn) CFSTI.

Nondestructive techniques are being developed to establish the container integrity and to study the various properties of isotope heat sources. An ultrasonic system was developed, and some work was done on the time transient infrared method. Data taken using prototype test equipment on simulated heat sources are given. (D.L.C.)

24903 (SC-RR-65-43) FINAL REPORT ON RE-ENTRY FLIGHT DEMONSTRATION NUMBER TWO. (Sandia Corp., Albuquerque, N. Mex.). Apr. 8, 1965. Contract AT(29-1)-789. 264p. Dep.; $6.00(cy), 6(mn) CFSTI.

RFD-2 was the second of Sandia's operational safety flight tests of systems for nuclear auxiliary power. The flight, conducted on October 9, 1964, was highly successful, with essentially all of the test objectives being met. This report describes the RFD-2 re-entry system and the instrumentation used to cover the flight, presents the data obtained, and gives an evaluation of the results of this test. (auth)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures.

Refer also to abstracts 24611 and 24697.

24904 (BNWL-45) PROMETHIUM-146, FISSION PRODUCT, AND TRANSURANIUM ISOTOPE CONTENT OF POWER REACTOR FUELS. COMPREHENSIVE CHEMICAL ANALYSES. F. P. Roberts and H. H. Van Tuyl (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1965. Contract AT(45-1)-1830. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

Four samples of fuel from the Yankee pressurized water reactor and three from the Vallecitos Boiling Water Reactor (VBWR) were analyzed radiochemically to determine the isotopic purity of the fission product promethium. Burnups were 13,700 to 31,800 Mwd/tonne of uranium for the Yankee fuel and 6540 to 17,400 Mwd/tonne of uranium for the VBWR. Total quantities of a number of other potentially valuable fission products and transuranium isotopes were also determined. The maximum ratio of ^{146}Pm to ^{147}Pm found in the Yankee Reactor was 4.7×10^{-6} on a Curie basis. Surprisingly, there was little variation between samples representing widely different reactor exposure; the ^{146}Pm/^{147}Pm ratio evidently reaches an equilibrium value at rather low exposures. The data obtained should relieve apprehensions concerning long-term availability of high quality (low gamma dose rate) promethium for isotopic heat source applications. Promethium sources containing 4 ppm ^{146}Pm will require no more shielding than ^{238}Pu for many applications. The fuel from the VBWR contained significantly less ^{146}Pm per Curie of ^{147}Pm than the Yankee samples. Because of this and the still rather high ^{148}Pm content, precise ^{146}Pm/^{147}Pm measurements were not made. Preliminary data indicate these values will be approximately 1×10^{-6} or about a factor of 4 lower than Yankee. Thus promethium from a VBWR type of reactor may be even more attractive as a heat source material and very nearly as good as that from the Hanford and Savannah River production reactors. The amounts of ^{90}Sr, ^{137}Cs, ^{147}Pm, ^{99}Tc, total palladium, ^{241}Am, ^{242}Cm, ^{244}Cm, ^{237}Np as well as the uranium and plutonium isotopes found for these fuels are also reported. Because these isotopes represent truly valuable by-products of atomic power production, their rates of generation must be factored into the design and operation of power reactors and fuel reprocessing facilities. The data presented can be used for testing the validity of computer techniques used for calculating these rates of generation. (auth)

24905 (HW-81256-1) DESIGN CRITERIA FOR PIPELINE TRANSFER FACILITIES FOR PROMETHIUM PRO-

CESSING AT THE STRONTIUM SEMIWORKS. W. W. Olson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 9, 1964. Contract AT(45-1)-1350. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The major items of work for the promethium-147 recovery system consist of the following: the installation of buried pipe from B-Plant to the Strontium Semiworks, with tie-ins to existing piping at each end; the addition of a pump to Tank 21 in C-Cell of Strontium Semiworks; fabrication of three jumpers needed within the B-Plant, two within the 244-CR Vault, and one in the 241-A-152 diversion box; construction of a jumper pit and jumper at the point where the pump-out line from Tank 21 ties into the new line; and the provision of cathodic protection to the buried line. Two new rectifier stations will probably be required. (auth)

24906 (ORNL-3792) RADIOISOTOPE PRODUCTION IN POWER REACTORS. A. F. Rupp, J. A. Cox, and F. T. Binford (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 57p. Dep.; $3.00(cy), 2(mn) CFSTI.

The possibility of producing large amounts of radioisotopes in 18 power reactors, together with some of the problems of establishing such a program, was investigated. Because of limitations of flux, irradiation time, and possible uses, seven radioisotopes—^{14}C, ^{60}Co, ^{170}Tm, ^{210}Po, ^{238}Pu, ^{242}Cm, and ^{244}Cm—were chosen for study. The amounts and specific activities which might be produced in all 18 reactors were calculated, and the approximate costs were estimated for one particular reactor. (auth)

24907 ISOTOPE SEPARATION BY DIFFUSION IN THE GAS PHASE. W. Kuhn, H. Sauter, and P. Laeuger (Universitat, Basel). Z. Naturforsch., 20a: 141-7(Jan. 1965). (In German)

The separation of a binary isotope mixture by diffusion in a stationary carrier gas was investigated experimentally and theoretically. For the case that one isotope is much rarer than the other, an explicit formula for the separation factor is given. The maximum possible separation factor is $a = D_{10}/D_{20}$, where D_{10} is the binary diffusion coefficient of the isotope i in the carrier gas. It is shown that the separation obtained is better than the smaller D_{10}/D_{12}. Experimental verification of the theory was made using the separation of $H_2{}^{16}O$ and $H_2{}^{18}O$ in Freon 12 (CCl_2F_2). The theory could be satisfied quantitatively under certain research conditions. (tr-auth)

24908 THERMAL DIFFUSION AND TRANSFER OF ROTATIONAL ENERGY. A. E. de Vries and A. Haring (FOM-Laboratorium voor Massascheiding, Amsterdam). Z. Naturforsch., 20a: 433-4(Mar. 1965). (In German)

Separations by thermal diffusion in the mixtures $^{14}N^{15}N/^{14}N_2$ and $^{15}N_2/^{14}N_2$ were made at average temperatures between 152 and 470°K. The results were consistent with the Chapman–Enskog theory in sharp contrast to separations in isotopic CO mixtures. From the difference in behavior between CO and N_2 it was concluded that energy transfer between translation and rotation of the molecules is not responsible for the influence of isotopic substitution on the thermal diffusion factor. (auth)

24909 RADIOAKTIVNYI MARGANETS. (Radioactive Manganese). V. I. Levin. Moscow, Atomizdat, 1964. 14p.

Descriptions are given of properties and applications of radioactive manganese isotopes prepared in a nuclear reactor and by accelerated charged particles. Chemical separation and purification of manganese isotope without carrier are discussed. (R.V.J.)

24910 METHOD OF DEUTERIUM ENRICHMENT OF HYDROGEN OR FOR THE PRODUCTION OF HEAVY WATER. Klaus Wetzel (to VEB Vakutronik). British Patent 967,000. Aug. 19, 1964. Filed Jan. 27, 1961.

A method is patented for the deuterium enrichment of hydrogen or for production of heavy water by isotopic exchange in a dual temperature hydrogen/water system. One stage of exchange takes place between liquid water and hydrogen in counterflow in a cold (<100°C) first column; and after vaporization of the water from the cold column, the steam is passed into a hot (300 to 700°C) second column together with and in concurrent flow to hydrogen in the presence of a catalyst supported on a fixed bed. The mixture of hydrogen and water vapor leaving the hot column is separated in a condenser. The water fraction impoverished in deuterium is discarded, fed to a lower stage of a cascade, or recycled to the upper end of the cold column. (B.L.M.)

MATHEMATICS AND COMPUTERS

Refer also to abstract 25071.

24911 (KAPL-M-6174) MOST— A MULTIDIMENSIONAL OPTIMIZATION SCHEME. C. R. Lubitz and G. A. Shanholt (Knolls Atomic Power Lab., Schenectady, N. Y.). July 1964. Contract W-31-109-eng-52. 32p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

MOST is a FORTRAN digital computer program designed to vary a set of coordinates $\{x_1, x_2, \ldots, x\} \equiv \vec{x}$ in such a way that a given function $y(\vec{x})$, $y(\vec{x}) \geq 0$, is minimized. (auth)

24912 (NAA-SR-Memo-10692) A TECHNIQUE FOR SOLVING DYNAMICS PROBLEMS BY DIGITAL COMPUTATION. R. W. Winson (Atomics International, Canoga Park, Calif.). Nov. 2, 1964. Contract [AT(11-1)-Gen-8]. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A set of functional equations is developed which greatly enhances the solution of system equations utilizing digital computers. The solution of the differential equations representing the system is not limited by any approximate numerical integration scheme; however, the computational time interval is limited to the extent that the system driving function can be represented by a series of steps and ramps. The method can be programmed with the ease of simple Euler integration, with the added advantage of requiring less computation time than either Euler or Runge-Kutta numerical integration schemes. (auth)

24913 (NYO-1480-14) A COLLECTION OF MATHEMATICAL COMPUTER ROUTINES. Miriam S. Shapiro and Max Goldstein (AEC Computing and Applied Mathematics Center, New York Univ., N. Y.). Feb. 1, 1965. Contract AT(30-1)-1480. 395p. Dep.(mn); $7.00(cy), 6(mn) CFSTI.

Presented are the write-ups and listings of some of the mathematical computer routines used on the IBM 7094 Computer at New York University. (auth)

24914 DIGITAL SYSTEMS FOR DATA HANDLING. R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). p.221-46 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965. (BNL-7739)

The use of digital computers in data acquisition and processing is discussed, including computer selection and analysis and control programs. A few systems using on-line digital computers are outlined, and the effects of computer-based systems on research techniques are briefly discussed. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

24915 (BNWL-6) IRRADIATED TUBE TESTING FACILITY. P. M. Jackson (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1964. Contract AT(45-1)-1830. 26p. Dep.; $2.00(cy), 1(mn) CFSTI.

A logical sequence for evaluating the mechanical properties of N-Reactor pressure tubing in the as-received condition is similar to evaluation after reactor service. The usual difficulties associated with testing a heavy tube to failure with 300°C water are compounded after reactor service by the high gamma radioactivity of the discharged tubes. Success in testing of discharged reactor pressure tubing in a pilot underwater facility led to the construction of an Irradiated Tube Testing Facility (ITTF) adjacent to the Radiometallurgy Building. The ITTF consists of a 10 ft 6 in. deep, water-filled basin 15 ft long by 10 ft wide, with six test chambers placed within the basin. These chambers are stainless steel bell jars that enclose the specimen, blast shielding, and electric furnace. The vessels exclude water from the hot specimen and furnace during testing and contain the pressure surge that occurs when the hot pressurized water flashes to steam upon failure of the test specimen. The ITTF basin is connected to the Radiometallurgy Building Basin by an underwater tube containing a conveyor system. The conveyor makes it possible to transfer highly radioactive materials with ease and safety. Remote handling tools were developed to measure the tubes, attach end closures, attach thermocouples, and load the specimen within the furnace containment vessels. (auth)

24916 (GEMP-334A) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. FOURTH ANNUAL REPORT. VOLUME I. MATERIALS. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 26, 1965. Contract AT(40-1)-2847. 232p. Dep.; $6.00(cy), 4(mn) CFSTI.

Developments are reported on materials for use as fueled and unfueled, high-temperature reactor components; radiation effects on the time-, temperature-, and stress-dependent properties of selected high-temperature alloys and refractory metals; radiation effects in BeO as a function of composition, grain size, density, porosity, and irradiation temperature and dosage; the diffusion of fission gases (Kr, Xe, and I atoms) in ceramic oxides subsequent to the injection via ion bombardment; the fission product transport processes in refractory-metal fuel systems at temperatures exceeding 1700°C; fertile material (thoria) in stabilized-fuel-BeO systems; oxidation- and corrosion-resistant fuel element materials with improved high-temperature properties; and high-temperature thermocouples and electrical materials development. (J.R.D.)

24917 (LA-3200) TECHNIQUES FOR HANDLING ALPHA-ACTIVE SPECIMENS FOR ELECTRON MICROSCOPY. Dana L. Douglass (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 1964. Contract W-7405-eng-36. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

Two replication procedures, suitable for use with smooth or rough surfaces of alpha-active specimens such as plutonium, are described. In addition, techniques for handling and examining thin foils of delta plutonium, as well as contaminated replicas in the electron microscope, are outlined. (auth)

24918 (LA-3217) SOLID SOLUTION CARBIDES OF URANIUM AND ZIRCONIUM. K. V. Davidson, R. E. Riley, and J. M. Taub (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 1964. Contract W-7405-eng-36. 34p. Dep.; $2.00(cy), 1(mn) CFSTI.

A summary is presented of various chemical reaction techniques used for the production of $(UC)_x(ZrC)_y$ powder, and the processes used to prepare intermediate raw materials used in certain of these techniques. Also reported are the results of analytical evaluations of the quality of the product prepared by each technique. A detailed account is given of the arc-melting of elemental constituents and of the subsequent thermal treatments used to remove extraneous phases. Analytical results are reported for the powders produced from arc-melted buttons, showing the reproducibility attainable by this procedure. (auth)

24919 (NLCO-922) A SEMICONTINUOUS PROCESS FOR THE REDUCTION OF URANIUM TETRAFLUORIDE WITH MAGNESIUM. C. A. Neu, Jr., G. Brodi, D. L. Elston, J. H. Trapp, and O. R. Magoteaux (National Lead Co. of Ohio, Cincinnati). Apr. 22, 1965. Contract AT(30-1)-1156. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

A semicontinuous process to produce uranium metal by reducing uranium tetrafluoride (UF_4) with magnesium was developed and demonstrated on a pilot scale. The UF_4 was reduced in an induction-heated, graphite reactor, positioned in a rammed zirconia housing. After reduction, the molten metal was cast into pigs in iron molds, vacuum remelted, cast into ingots, and fabricated into fuel cores. The cores were found to be satisfactory for use in the production reactors. The operation and development of equipment as well as the results of pilot-scale demonstration tests are described. (auth)

24920 (NMI-2136) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report to United States Atomic Energy Commission for the month January 1965. (Nuclear Metals, West Concord, Mass.). Mar. 8, 1965. Contract AT(30-1)-2784. 39p. (NYO-2784-7) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress in the fabrication of W–25% Re tubing is reported. A significant advance in the drawing of the extruded stock was the more effective reeling after moving-mandrel drawing, achieved with the aid of harder mandrels. Re-extruded tubing of the 80-mil OD by 8-mil wall size was successfully drawn over a deformable mandrel consisting of molybdenum and calcium carbide extrusion fillers. A metallographic examination of this tubing is included as are the extrusion and drawing conditions for all tubing. Progress is also reported in the study of the fundamentals of single-crystal deformation in zone-refined beryllium. (W.L.G.)

24921 (NNES-IV-12A) METALLURGY OF URANIUM AND ITS ALLOYS. J. C. Warner, ed. (Atomic Energy Commission, Washington, D. C.). 1953. 200p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

The most significant part of the work on the metallurgy of uranium and its alloys which was carried out in the Manhattan Project, is reported. The six chapters cover the small-scale production, melting, and casting; fabrication; physical and mechanical properties; metallographic techniques; and binary alloys. (D.L.C.)

24922 (ORNL-3731(p.1-110)) ADVANCED GAS-COOLED REACTOR PROGRAM. (Oak Ridge National Lab., Tenn.).

Studies of the effects of process conditions on the properties of pyrolytic C fuel coatings were continued. In experiments in which deposition temperatures and methane pressures were varied, the microhardness of coatings increased with increasing methane pressures. The physical structure of coatings was studied by x-ray-diffraction and electron microscopy. Results of coated-fuel-particle density and shape investigations are included. Phase studies of Th–U–C systems are discussed. Results of fueled graphite sphere impact testing are discussed along with results of irradiation tests. (J.R.D.)

24923 (UNC-5081) CARBIDE FUEL DEVELOPMENT. Phase V Report, October 1, 1962–September 30, 1963. A. Strasser, D. Stahl (United Nuclear Corp., White Plains,

N. Y. Development Div.), K. Taylor, and J. Andersen (Carborundum Co., Niagara Falls, N. Y.). June 30, 1964. Contract AT(30-1)-2899. 97p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Fuel Fabrication and Evaluation. Test samples of solid solution $(U_{0.95}Pu_{0.05})C_{0.98}$ for physical property measurement were fabricated by cold pressing and sintering powders prepared by the carbon reduction of oxides. The preparation of $(U_{0.8}Pu_{0.2})_2C_3$ was studied by a similar method. The preparation of PuO and $(U_{0.8}Pu_{0.2})O$ was studied. Products containing predominantly monoxide were identified. Vacuum annealing studies of $(U_{0.8}Pu_{0.2})C_{0.95}$ and $(U_{0.8}Pu_{0.2})C_{0.85}$ + 0.1 wt % Ni showed that the oxygen and nickel contents could be reduced significantly. The effect of aging on the lattice parameter of $(U_{0.95}Pu_{0.05})C_{0.98}$ and $(U_{0.8}Pu_{0.2})C_{0.95}$ was found to be insignificant in periods up to 7 months. Microprobe analyses of $(U_{0.8}Pu_{0.2})C_{0.95}$ + 0.1 wt % Ni showed good plutonium and nickel uniformity. Compatibility tests between $(U_{0.95}Pu_{0.05})C_{0.98}$ with and without nickel vs type 316 stainless steel, 2¼ Cr−1 Mo steel, niobium, niobium−1 wt % zirconium, and Zircaloy-2 up to 4000 hr and 816°C showed no reactions except for Zircaloy-2 and one sample of niobium-1 wt % zirconium. The coefficient of expansion of $(U_{0.95}Pu_{0.05})C_{0.98}$ at 25 to 1400°C was measured as 12.6×10^{-6}/°C, and that of $(U_{0.95}Pu_{0.05})C_{0.98}$ + 0.1 wt % Ni at 25 to 1400°C was measured as 12.2×10^{-6}/°C. An initial melting point measurement of $(U_{0.95}Pu_{0.05})C_{0.98}$ gave 2500°C. Irradiation Tests. Twelve samples of clad $(U_{0.8}Pu_{0.2})C_{0.95}$ were inserted in the test reactor, and the irradiation of four of the samples was completed at their target burnups of 5.0 to 6.8×10^{20} fiss/cm³ (15,700 to 21,400 Mwd/t) average. The post-irradiation examination in progress for the four specimens irradiated 355 to 395 w/cm average at fuel center temperatures of 1000 to 1400°C and clad surface temperatures of 600 to 800°C shows that with the exception of a localized rupture the stability of the fuel is excellent. The clad dimensions did not change, fission gas release was low (the amount expected from recoil), fuel dimensional changes were relatively small (up to 5% volume increase), and the microstructure of the fuel did not change. The cause for a localized rupture in one specimen is believed to be an operating defect of the irradiation capsule. The in-pile thermal conductivity of the fuel in the temperature range of 700 to 1000°C was estimated to be an average of 0.046 cal/sec-cm²-°C/cm. This compares favorably with out-of-pile measurements, and is about 84% of the value for UC. (auth)

24924 BERYLLIUM OXIDE. Proceedings of The First International Conference, Sydney, Australia, October 21-25, 1963. R. Smith and J. P. Howe, eds. J. Nucl. Mater., 14: 1-498(1964). (CONF-281)

Proceedings of the First International Conference on Beryllium Oxide are presented. Fifty-five papers are included. Separate abstracts were prepared for 14 papers. The remaining papers were previously abstracted for NSA and appeared as abstracts 17: 6734, 42188; 18: 8798, 20016, 20017, 20116, 20462, 20497, 20498, 20499, 20500, 20501, 20502, 20503, 20504, 20505, 20570, 20571, 20572, 20573, 20574, 20576, 20577, 20604, 20605, 20607, 20608, 20609, 20610, 20611, 20613, 20615, 21658, 21659, 21660, 22417, 22438, 22531, 23042, 32105; and 19: 23030. (M.C.G.)

For abstracts of individual papers see: 24516, 24925, 24962, 24963, 25020, 25021, 25022, 25023, 25061, 25062, 25063, 25064, 25065, and 25066.

24925 AVAILABILITY AND COST OF NUCLEAR-GRADE BERYLLIUM OXIDE. W. J. Wright (AAEC Research Establishment, Lucas Heights, Australia). J. Nucl. Mater., 14: 49-54(1964).

The present market for beryllium oxide powder in relation to reactor requirements was surveyed and trends that may affect the market up to 1970 are indicated. Particular attention was paid to Australian requirements in relation to its H.T.G.C. reactor study. Properties of the beryllium oxide required for reactor uses are described. (M.C.G.)

24926 HOW TO PREPARE HYDRIDED ZIRCALOY-2 FOR MICROSCOPIC EXAMINATION. McIntyre R. Louthan, Jr. and Charles E. Padgett (E. I. du Pont de Nemours & Co., Inc., Aiken, S. S.). Metal Progr., 87: No. 5, 133(May 1965).

A technique of mechanical polishing and chemical etching that was developed for revealing the microstructure of Zircaloy-2 and zirconium hydride platelets simultaneously is described. Large grained Zircaloy-2 that was prepared to reveal precipitated hydrides and grain structure is illustrated. Using this technique, grain boundaries, twin boundaries, and hydrides are also in focua and easily observable at 500 ×. (P.C.H.)

24927 METALLOGRAPHY PREPARATION FACILITY, HIGH LEVEL CAVES, CELLS 7 AND 8 (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 68 drawings. (CAPE-1163)

The remote metallography preparation facility, located in the high-level caves in 1958, was enlarged in 1960 and again in 1962. Cells 7 and 8, and other cells are 6 ft × 6 ft and are equipped with Model 8 master-slave manipulators and an electro-mechanical heavy duty manipulator. The polishing cell contains 5 vibratory polishers and an ultrasonic cleaning station. The mounting and grinding cell contains an ultrasonic cleaner, mechanical grinders, and vacuum impregnating equipment. (For details, see TID-4100) (M.C.G.)

24928 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM. Alan Robert Gibson and Ronald George Avery (to United Kingdom Atomic Energy Authority). British Patent 966,807. Aug. 19, 1964. Filed May 10, 1961.

A method and apparatus are described for the production of U metal or U alloys by the electrolysis of a suspension of UO_2 in a molten alkaline earth halide electrolyte using an anode and a metal cathode that are both unreactive with respect to the metal halide. The apparatus is comprised of a crucible and lid of a refractory material, cathode, anode, stirring means, and means for maintaining an inert atmosphere within the crucible. The temperature of the suspension is maintained below the melting point of U metal. For the production of a U alloy, a metallic cathode that is unreactive to the electrolyte but that forms an alloy with U is used. Preferred electrolytes are calcium and magnesium chlorides. (B.L.M.)

24929 NIOBIUM ALLOYS. George Thomas John Mayo and Geoffrey Vernon Smith (to The Plessey Co., Ltd.). British Patent 977,512. Dec. 9, 1964. Filed Aug. 2, 1960.

A process is reported for the production of alloys of Nb that are particularly suitable for applications where the material is subjected to oxidation effects at very high temperatures, e.g. turbine blades or fuel cans in reactors. The alloys have a composition consisting of 40 to 70 at. % of Nb with 30 to 60 at. % of a combined pair selected from the group Cr, Co, and Fe with at least 15 at. % of each one of the selected pair always present. Any balance of the alloy consists of one or more elements selected from the group Ti, Mn, Ge, Rh, and Sn. The alloy is formed by compacting the mixed constituents in powder form, and then melting the compacted mixture by an induction melting process. (B.L.M.)

24930 IMPROVEMENTS IN OR RELATING TO LOW-CONTENT URANIUM ALLOYS. (to Commissariat a l'Energie Atomique). British Patent 978,449. Dec. 23, 1964. Priority date July 21, 1961, France.

A process is reported for treating a low content U alloy to give them a fine-grained and homogeneous α-phase structure. The U is alloyed with a small amount of one or more of the following elements: Fe, Al, Cr, Si, Mo. The alloy is annealed in the β-phase for from 5 to 15 min at a temperature of 710 to 760°C and then quenched. (B.L.M.)

Corrosion

Refer also to abstract 24997.

24931 (CNLM-5351) LOW PRESSURE OXIDATION OF COLUMBIUM−1 ZIRCONIUM. Robert W. Harrison and Eugene J. Delgrosso (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.).

Apr. 30, 1964. Contract AT(30-1)-2789. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The reactions of Nb–1 Zr alloy with oxygen were investigated at various temperatures and pressures. Continuous weight gain measurements were made using a vacuum thermobalance capable of detecting a 0.15 ± 0.05 mg weight change at temperatures up to 3500°F from atmospheric pressure to 10^{-6} mm Hg. These data are presented for oxidation at 1000, 1400, and 1600°F from 1×10^{-3} to 1×10^{-5} mm Hg for 10-hour test periods. Corresponding quantitative internal oxidation measurements were performed to correlate hardness, penetration depth, and oxygen content. The following reactions occurred sequentially: adsorption and solution of oxygen creating a dispersed ZrO_2 subscale by internal oxidation, formation of orientation-dependent NbO, oxidation of NbO to NbO_2, and subsequent establishment of a continuous NbO_2 layer. This NbO_2 layer caused protective oxidation and directly affected the total weight gain and degree of oxygen penetration. NbO indirectly influenced protective oxidation behavior, since the quality of the NbO_2 scale apparently was related to the amount of NbO initiating NbO_2. Oxidation parameters are indicated for protective and nonprotective scale formation, and corresponding internal oxidation. Within the pressure ranges investigated, some of the most severe contamination occurred at the lowest pressures when NbO_2 scale was not produced. The structural changes, subscale and scale formation caused by oxidizing Nb–1 Zr alloy are illustrated schematically. (auth)

24932 (COO-1319-12) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, December 17, 1963–March 16, 1964. F. H. Beck, M. G. Fontana, and J. P. Hirth (Ohio State Univ. Research Foundation, Columbus). Mar. 31, 1964. Contract AT(11-1)-1319. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The proposed and preliminary preparation and fabrication techniques of ingots and single-crystals of Cr–Fe–Ni alloys are reported. Autoclaves to be used in stress corrosion cracking experiments are described. (W.L.G.)

24933 (COO-1319-15) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, March 17–June 16, 1964. F. H. Beck, M. G. Fontana, and J. P. Hirth (Ohio State Univ. Research Foundation Columbus). June 17, 1964. Contract AT(11-1)-1319. 56p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Progress is reported in the study of stress corrosion cracking. A literature survey, which emphasizes some of the important experimental information in the areas of defect structure and electrochemistry, was conducted. 35 references are given. (W.L.G.)

24934 (COO-1319-21) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, September 17, 1964–December 16, 1964. F. H. Beck, M. G. Fontana, and J. P. Hirth (Ohio State Univ. Research Foundation, Columbus). Jan. 15, 1965. Contract AT(11-1)-1319. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the study of stress corrosion cracking. Preliminary experimental results, observations, and difficulties experienced in the operation of the experimental equipment are described. (W.L.G.)

24935 (EURAEC-1295) A STUDY OF SOME METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Final Report No. 2. (Brussels Univ. (Belgium). Faculte des Sciences). Sept. 30, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10-TEEB. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Research on the electrochemical behavior of oxidizable metal surfaces is described. The capacitive, coulometric, and reactive characteristics of Pt electrodes in sulfuric acid were measured. A description of the apparatus used is included along with discussions of results. (J.R.D.)

24936 (EURAEC-1308) CORROSION STUDIES ON STEELS IN WATER AND STEAM AT HIGH TEMPERATURE. Quarterly Progress Report No. 10, October 1–December 31, 1964. (Societe d'Etudes, de Recherches et d'Applications Pour l'Industrie, Brussels (Belgium)). Jan. 29, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 089-62-7 RDB. 82p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The static corrosion tests in superheated steam were continued for stainless steel type AISI 304, for the purpose of finding the type of oxidation obtained after sanding the surface of the test pieces. Silica sanding by compressed air has the same behavior as all the cold-worked states studied up to the present. In addition, the first tests in steam at 500°C, with the addition of oxygen, have been carried out. Subject to confirmation, the addition of a quantity of oxygen ≤80 ppm does not appear to greatly modify the behavior in superheated steam and, in particular, the advantage gained by surface work-hardening. Finally, it will be noted that a very light electrolytic polishing of milled test pieces (1 to 1.5 μ solution), does not change their behavior in superheated steam at 500°C whilst there is an extremely harmful effect in respect to corrosion in water at 300°C. Detailed metallographic examinations effected on different samples of 18-10 steel treated mechanically and then oxidized in steam at 500°C show that the presence of oxide precipitates in the metallic cold-worked area, under the continuous layer of oxides, is very probable. The dynamic corrosion tests in water at 300°C, 150 kg/cm², and 10 m/sec, effected for varying periods up to 2,000 hours, have been completed. These tests show that the corrosion rate of 18-10 steel becomes very low above 1,000 hr of testing. Tests of extremely long duration would be necessary to define its value more accurately, which is between 0 and 5 mg/dm²/month. It is confirmed that the "surface state" factor has no appreciable influence on the rate of 10 m/sec. For boiler steel, it is verified that the "metal in water" component constitutes the principal corrosion element, which progresses linearly at a rate of approximately 500 mg/dm²/month. The adherent oxide skin on the test pieces is invariably 1 μ, whatever the duration of the test. The classification of the surface states remains that obtained during earlier static tests, the differences being greatly reduced, however. It is probable that the residual differences observed at the rate of 10 m/sec, are only apparent and attributable to the incidence of the surface treatment on the true surface of the test pieces. (auth)

24937 (EURAEC-1346) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 3. Report 438-3. B. N. Ferry (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Apr. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3208. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Nitrided type 304 stainless steel wires were metallographically investigated to determine how even the nitriding was in the longitudinal and transverse directions. Investigation of the nitrogen absorption rate showed that with 100% ammonia, the nitride case formation and percent nitrogen for short nitriding times increased rapidly, but as nitriding time lengthened, the rate dropped considerably. Nitriding with an ammonia hydrogen atmosphere caused a drastic reduction in nitriding rate. The nitride case was eliminated when the ammonia was diluted with 50% by volume or more of hydrogen. X-ray diffraction studies of nitrided wire specimens showed the presence of four phases, CrN, Cr_2N, solid solution of nitrogen in austenite, and γ′ consisting of an ordered lattice probably of Fe_4N or possibly $(Fe_xNi_y)_4N$. (W.L.G.)

24938 (NP-15024) ULTRASONIC-INDUCED CAVITATION IN LIQUID METALS AT 500°F. Internal Report 05031-3-I. R. Garcia and F. G. Hammitt (Michigan Univ., Ann Arbor. Dep. of Nuclear Engineering). Apr. 1965. 8p.

Cavitation-erosion data were obtained for 304 stainless steel, 316 stainless steel, Mo–½Ti, T-111, Nb–1 Zr, and

T-222 in 70% Pb–30% Bi alloy at 500°F. The data are presented in terms of accumulative weight and penetration depth vs time; T-111 exhibits the greatest resistance to cavitation on the basis of penetration. The mechanical properties were also measured at 500°F, and correlations are made with cavitation-erosion data. The materials are rated on the basis of the penetration depth and the mechanical properties. (D.L.C.)

24939 (ORNL-3784) SNAP-8 CORROSION PROGRAM. Quarterly Progress Report for Period Ending November 30, 1964. H. W. Savage, E. L. Compere, R. E. MacPherson, W. R. Huntley, and A. Taboada (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 63p. Dep.; $3.00(cy), 2(mn) CFSTI.

Results of analytical examinations of the corrosion loops show very little metal migration occurred in low-oxygen-content NaK at both temperature levels investigated; however, carbon migration was quite severe. Corrosion of the iron-base alloy in the low-oxygen-content NaK was very low, as compared with corrosion of the chromized Hastelloy N, which ranged from three to seven times as great. Increasing the oxygen content of the NaK accelerated the corrosion rate on all materials; however, the effect on the corrosion rate of Hastelloy N was much less than that experienced by iron-base alloys. High corrosion rates were observed in some loops run with low oxide content. The results observed would be consistent with a hypothesis that intermittent high oxide situations in an otherwise low oxide regime are as damaging as continuous high oxide contents. Additions of H_2 to the NaK did not produce any discernible effects on the mass transfer rates. Furthermore, the extent of carbon migration apparently was not affected by hydrogen or oxygen levels in the NaK. A study was made for determining the effects of decarburization on selected mechanical properties of Croloy 9M. Sheet tensile specimens were decarburized to a carbon content of approximately 0.002 to 0.01% by exposure to NaK. A study was made of soluble getters for minimizing hydrogen egress in the SNAP-8 system. Three exploratory experiments were conducted to determine the hydrogen solubility relationship for NaK containing different quantities of lithium. At a pressure and temperature where hydride would not precipitate in pure NaK, the uptake of hydrogen was found to be substantially greater in the lithium-bearing NaK, and this was attributed to precipitation of LiH. A simple mass-action model that describes these findings was generated. Hydrogen solubility in NaK-78 was investigated and solubility versus partial pressure dependencies were determined at temperatures of 572 and 626°F. Hydrogen permeation through type 316 stainless steel in both the absence and presence of NaK at 1000, 1100, and 1300°F was studied. Permeation data were also determined for Croloy 9M in the absence of NaK at the same temperature levels. (auth)

24940 REACTION OF FLOWING STEAM WITH THE REFRACTORY METALS NIOBIUM AND TANTALUM. Martin Kilpatrick and Stanley K. Lott (Argonne National Lab., Ill.). J. Less-Common Metals, 8: 299-305(May 1965).

The reaction of niobium and tantalum with steam at elevated temperatures was investigated. Niobium obeyed linear kinetics over the temperature range 1050–1500°C after a brief induction period; the oxide was identified as β-Nb_2O_5. Tantalum, on the other hand, followed a paralinear rate law at temperatures from 950 to 1300°C with the initial parabolic rate of reaction being followed by transition to a linear rate. The parabolic portion can be represented by a linear Arrhenius plot while the linear portion does not follow an Arrhenius relationship. Tantalum forms β-Ta_2O_5 and, as the transition to α-Ta_2O_5 takes place around 1300°C, the reaction becomes too rapid to measure. (auth)

24941 CORROSION STUDIES OF REACTOR MATERIALS BY HIGH TEMPERATURE AND HIGH PRESSURE WATER LOOP. III. CORROSION OF Zr ALLOYS, (2). Sueo Nomura, Noboru Ito, Hiroharu Itami, and Cho Akutsu (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 148-57(Mar. 1965). (In Japanese)

The corrosion of Zr-2 and -4 coupons in flowing water, at 2.5 and 12.0 m/s, was studied at 300° and 320°C. The weight gain of coupons by dynamic corrosion was represented as the following function of time, similarly to the case of static corrosion: $\log\Delta W = \log K + n \log t$, where the constants K and n are both dependent on the flow conditions and temperature of water (K generally increases with temperature at same flow rate). From a comparison of the constants under different flow conditions, it is suggested that the corrosion behavior of the coupons is more similar to static corrosion when exposed to flow at 2.5 m/s than at 12.0 m/s, in which case the dissolution of the oxide film could be observed by measuring the impedance of the oxide film. The effects on corrosion of initially dissolved oxygen concentration and of replacement of the samples were found to be negligible. Hydrogen pick-up by the coupons was little influenced by the flow conditions, and the difference of pick-up between Zr-2 and Zr-4 was much reduced at 320°C. A large amount of crud deposition was experienced on the coupons heated to 320°C, though coupons replaced during an experiment under the same temperature were found to be almost free of crud. (auth)

24942 ON THE HIGH-TEMPERATURE OXIDATION OF SOME ZIRCONIUM ALLOYS. Joachim Staab (Universitat, Frankfurt am Main). Z. Physik. Chem. (Frankfurt), 43: 371-87(Dec. 1964). (In German)

The oxidation isotherms of Zr (reactor grade), Zr–1.0 Mo and Zr–1.0 Cu in CO_2 and CO atmospheres were experimentally determined at temperatures between 500 and 900°C and expressed through a time law of the form $\Delta m = k \cdot t^n$, in which 0.4 is the numerical value of the exponent n, so that neither a pure parabolic nor a pure cubic time law exists. In contrast with unalloyed Zr, the Zr–Mo alloy showed a poorer and the Zr–Cu alloy an improved nonscaling characteristic. The activation energies were 40,600 ± 2000 cal mol^{-1} for pure Zr, 37,900 ± 2000 cal mol^{-1} for Zr–Mo, and 37,200 ± 2000 cal mol^{-1} for Zr–Cu. The activation entropies were a little under zero. The essentially low oxidation velocity in Co atmosphere at higher temperatures was probably to be attributed to a reaction inhibition by deposition of particles of free carbon in the scaling layer. (tr-auth)

24943 KORROZIYA URANA I EGO SPLAVOV. (Corrosion of Uranium and Its Alloys). V. V. Gerasimov. Moscow, Atomizdat, 1965. 96p.

Corrosion behavior of uranium and uranium alloys in various media in nuclear industry is discussed. Data are given on the effects of thermal treatment, cladding, and corrosion media on the corrosion resistance of U and its alloys. (R.V.J.)

Fabrication

Refer also to abstract 25706.

24944 (AAEC/E-132) EXPERIMENTS IN EXTRUSION. PART 3. THE MECHANICS OF EXTRUSION OF BERYLLIUM. W. J. Wright, J. M. Silver, and J. F. Whatham (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1964. 27p. Dep.(mn).

The extrusion pressures determined for beryllium and mild steel over a wide range of reductions in area at temperatures between 750 and 1050°C are significantly lower than those reported previously. This is attributed to better control of temperature in the work reported. The effects of container friction were assessed and the coefficient of friction between tooling and billets was estimated as 0.03–0.035 when using graphite lubricants. The flow of metal in extrusion through various dies was examined using gridded billets; the velocity profiles and extent of the plastic field were determined. The work was applied to a study of the shapes developed from plane interfaces in the billets during extrusion; the interface shape necessary in the original billet to produce a plane interface in the extruded section

was determined and applied in the basic extrusion technique to improve the yield of product. (auth)

24945 (ASD-TDR-63-829(Pt.I)) DEVELOPMENT OF OPTIMUM PROCESSING PARAMETERS FOR REFRACTORY METAL FOIL. J. J. Buchinski and G. P. Trost (Metals and Controls Inc., Attleboro, Mass.). Oct. 1963. Contract AF33(657)-9384. 125p.

Approximately 110 pounds of extensively evaluated high quality 2, 6, and 10-mil D-36 and B-66 niobium-base alloy foil was shipped to Project 651G contractors. Additional quantities of Nb-752, SNb-291, and C-129 foil were also produced. Quality specifications for both the starting reroll stock and finished foil were established. Roll processing schedules, associated rolling mill variables, flattening procedures, and cleaning techniques were also studied. Critical strain studies failed to show the existence of this phenomenon in the first three alloys named above. Processes for producing foil meeting high standards of surface quality and thickness tolerance were developed. Flatness of foil was felt to be one of the major remaining problems, along with the annealing. Interstitial pickup in the final foil was of a low to moderate level, with the result that mechanical property changes between reroll stock and finished foil were very small. (auth)

24946 (ASD-TDR-63-829(Pt.II)) DEVELOPMENT OF OPTIMUM PROCESSING PARAMETERS FOR REFRACTORY METAL FOIL. J. J. Buchinski, G. P. Trost, and P. A. Dion (Metals and Controls Inc., Attleboro, Mass.). June 1964. Contract AF33(657)-9384. 177p.

Approximately 480 pounds of high quality 2, 6, and 12-mil B-66, Nb-752, D-43, and T-111 alloy strip were produced, extensively evaluated, and shipped to other Government Contractors for use on materials testing programs. Recommendations for processing and quality assurance procedures for the production of high-quality refractory-metal foil were prepared. Particular consideration was given to annealing, handling practices, and economics. Materials specifications for reroll stock and finished foil were prepared. Rollability studies of program alloys were conducted on an instrumented laboratory rolling mill. Flatness correction for 6-mil foil through the use of the roller-stretching principle was demonstrated. Work hardening and recrystallization characteristics of the foil materials were determined. A special study of the B-66 cracking problem was conducted. (auth)

24947 (EURAEC-1280) STUDY OF JOINTS WELDED IN VERY THICK STEEL PLATES. Quarterly Report No. 2, October 1–December 31, 1964. (Institut de Soudure, Paris (France)). Jan. 30, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 007-64 TEEF (RD). 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A method was devised to study the thermal cycle of a multi-pass submerged-arc welding operation on thick steel plates. Temperature measuring probes were inserted through holes drilled in the steel plates to a position in the surface of the groove to be welded. Results are not given, but it was concluded that the method is suitable to the experimentation contemplated. (W.L.G.)

24948 (GEAP-4756) FABRICATION AND TESTING OF DISSIMILAR METAL JOINTS FOR THERMAL SPECTRUM SUPERHEAT REACTORS. H. J. Busboom and M. E. Snyder (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec. 1964. Contract AT(04-3)-189. 58p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An investigation was carried out to develop a transition tube containing a mechanically reliable, metallurgically bonded joint between Zircaloy-2 and Incoloy-800. Hot tandem extrusion experiments demonstrated that large diameter transition joints can be fabricated between these materials reliably, economically, and with a high degree of reproducibility. It was also demonstrated that long Zircaloy-2 tubes can be extruded with these joints, thus allowing the Zircaloy process tube to be fabricated along with the joint, and resulting in a substantial cost reduction. The thermal cycling and corrosion behavior of tandem extruded transition joints (Zircaloy-2 to Type-304L, and Zircaloy-2 to Incoloy-800) were investigated. Neither thermal cycling (1000 cycles) between 100 to 600°F nor long-term exposure (~3500 hours) at 545°F alter the bond integrity or mechanical properties of these joints. The insulating properties of a Zircaloy-2 process tube design using a stainless steel linear were found to be satisfactory from a design standpoint. (auth)

24949 (LA-3232) THE FORMING AND EVALUATION OF UO_2 AGGLOMERATES FOR CERMET APPLICATIONS. William H. Lenz and Marvin C. Tinkle (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 15, 1964. Contract W-7405-eng-36. 43p. Dep.; $2.00(CFSTI).

The formation of spheroidal UO_2 agglomerates was investigated with a view toward application in refractory metal cermets. Essentially the selected process consisted of compacting a mass of fine UO_2 powder, crushing the compact to the desired screen sizes, and spheroidizing the crushed fragments by mechanical abrasion. Spherodizing was attempted by combining shaking, rolling, or vibratory motion with conventional screens or abrasive surfaces. The crushed particles covered an extensive hardness range which was reflected in the results obtained. Evaluation of the various products was accomplished by microscopic inspection, porosimetry, chemical analysis, and by sintering blends made with refractory metal powders. The experimental products were also compared in various ways with similar commercial materials and with UO_2 agglomerates furnished by another laboratory. (auth)

24950 (LA-3255) FABRICATION OF TEFLON BY HYDROSTATIC PRESSING. J. S. Church, J. K. Donahoe, and H. Sheinberg (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Aug. 10, 1964. Contract W-7405-eng-36. 19p. Dep.; $1.00(cy), 1(mn) CFSTI.

Functional parts have been produced by hydrostatic pressing of Teflon. Pressures ranging from 5,000 to 30,000 psi can be used. Shrinkage of parts from pressing sac cavity dimensions to the sintered form is anisotropic, but falls into patterns related to both size and shape of the product. All commercially available forms or grades of Teflon have been processed satisfactorily. The process is particularly suited to production of shapes difficult or impossible to produce by the more conventional methods described in the literature. (auth)

24951 (NAA-SR-8541) A DEVICE FOR INTERNAL T.I.G. ARC WELDING OF TUBE TO TUBE-SHEET JOINTS. G. Kazlauskas (Atomics International, Canoga Park, Calif.). Mar. 15, 1965. Contract AT-11-GEN-8. 46p. Dep.; $0.75 (cy), 1(mn) CFSTI.

A weld head was developed and built which is capable of successfully butt-welding tube to tube-sheet by an internal, inert-gas-shielded-tungsten-arc welding process. This development is especially significant for weld joints on supercritical, modular, steam generators. (auth)

24952 (NMI-2523) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. HOT COEXTRUSION OF URANIUM MONOCARBIDE FUEL ELEMENTS. Summary Technical Report, July 1, 1961–October 30, 1962. J. G. Hunt and P. Loewenstein (Nuclear Metals, West Concord, Mass.). Sept. 8, 1964. Contracts AT(30-1)-1565 and AT(30-1)-2784. 38p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

A hot coextrusion process for refractory metal-clad uranium monocarbide has been developed that demonstrates that UC can be extruded in a manner analogous to metals. Based on techniques previously used for metallic fuel elements and hot extruded UO_2, the process involves coextrusion of UC powders or castings in various stoichiometries within molybdenum canning at temperatures between 1600 and 1900°C to yield fully dense rods. Various claddings, such as niobium–1% zirconium, molybdenum, and tungsten, can be coextruded with the carbide. The principles employed, the experiments for process development, the process sequence, the properties of coextruded rods, and fabrication of irradiation specimens are discussed. (auth)

24953 (NMI-7262) DEVELOPMENT OF FABRICATION PROCESSES FOR CONCENTRIC DRIVER TUBES FOR THE

HWCTR. S. Isserow, D. M. Davies, W. J. Richmond, A. B. Bremer, and T. A. Tarpey (Nuclear Metals, West Concord, Mass.). Sept. 4, 1964. Contract AT(30-1)-1565. 56p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Successful billet core casting techniques and billet designs were developed for both outer and inner tubes of the two-tube assembly. A total of four outer and five inner tubes with shallow ribs were extruded during this program. Evaluation of the outer extruded tubes proceeded to the point of establishing that the coextrusion process was satisfactory. Two methods were attempted for obtaining integral ribs on the outside of the inner tubes. The first derived the ribs from stock inserted in the billets as Zircaloy strips. This method was successful for only the first of three tubes. The second method, in which the rib stock was machined as part of the Zircaloy sleeve of the billet, apparently gave two good tubes. Full-height ribs were successfully electron beam welded to the extruded shallow ribs, on sample lengths of the first inner tube. Coextrusion conditions for both outer and inner tubes were determined by small-scale rod extrusions and by hot hardness measurements of the component materials. The extrusion billets were essentially similar to previous Nuclear Metals design using extrusion tooling of standard design. (auth)

24954 (TID-21790) PRODUCTION DEVELOPMENT OF Cb-1 Zr ALLOY TUBING. [L. M. Raring] (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). [nd]. Contracts AT(11-1)-229 and AT(30-1)-2789. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A brief survey is presented of the experience gained in the development of Nb-1 Zr alloy tubing for use in corrosion loops. The fabrication methods are described, and the quality inspection methods used are discussed. (D.L.C.)

24955 (USBM-RC-1157) PREPARATION AND EVALUATION OF RHENIUM AND RHENIUM-BASE ALLOYS. Final Report, March 1, 1963-June 30, 1964. C. E. Armantrout and H. Kato (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). For Univ. of California Lawrence Radiation Lab., Livermore. 36p. (UCRL-13143). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Pure Re and Re-base alloys were not amenable to hot or warm rolling at any temperature from 900 to 1600°C. An optimum cold-working procedure was developed that utilized cold press forging with reductions of up to 40%, annealing and then cold rolling with reductions, using multiple passes, of 20 to 30% between each anneal. The use of tool steel anvils and rolls hardened to near Rockwell C 60 or higher is mandatory in the forming of these materials or excessive tears and cracks develop during the forming operation. Re consolidated by nonconsumable-electrode arc melting and cold forming to sheet has the following mechanical properties: tensile strengths-109,000 to 130,000 psi; yield strengths-16,100 to 17,700 psi; and modulus of elasticity-54×10^6 psi. These values on the mechanical properties are low when compared to results reported by other investigators. The variations noted were probably caused by the purity of the product tested. The sheet tested in this investigation was 99.9+ percent Re with very low C content. The repeated cold working and annealing of cast Re ingots resulted in an appreciable increase in hardness from Rockwell A 42-43 to Rockwell A 58-62. The alloys that were amenable to cold working and that were subsequently tested in tension were of the solid-solution type or were amenable to heat treating in a solid-solution range. The alloy additions that strengthened through solid solution mechanisms had high tensile strengths, up to 231,000 psi, yield strengths up to 119,000 psi with elongations near 20%. The modulus of elasticity for the alloys was near 60×10^6 psi. The recrystallization temperature of cold-worked Re is between 1550 to 1600°C. The specific vibration damping capacity of pure Re, 16.2% as determined at a stress level of 5000 psi, puts this material in the high damping capacity category. The a and c dimensions of the CP hexagonal structure of pure Re are expanded when either Mo or W is added. The solubility of W in Re appears to lie between 10 and 12.5%. The solubility of Ni in Re at 1670°C is less than 0.5% and greater than 0.2%. The melting point of the peritectic is less than 1670°C. Melting studies at high pressure show that out of a possible 7.5% Ni, 0.5% can be retained when melting is conducted at 1000 psi for 2 and 3 melts, 3.7% when melting is conducted at a pressure of 1500 psi for 2 melts, and 4.4% when melting is conducted at a pressure of 1600 psi for 3 melts. (auth)

24956 (WADD-TR-61-72(Vol.VII)(Suppl.)) RESEARCH AND DEVELOPMENT OF ADVANCED GRAPHITE MATERIALS. SUPPLEMENT TO VOLUME VII. HIGH-DENSITY RECRYSTALLIZED GRAPHITE BY HOT FORMING. G. L. Rowe and M. B. Carter (National Carbon Co., Lawrenceburg, Tenn. Advanced Materials Lab.). July 1963. Contract AF33(616)-6915. 42p. (AD-607241). $2.00(CFSTI).

A description is given of the development and fabrication techniques utilized in the scale-up of grades ZTE and ZTF graphite to 30-inch diameter sizes. Grades ZTE and ZTF graphite which are normally characterized by a bulk density range of 1.92 to 1.97 g/cc and 1.97 to 2.02 g/cc, respectively, are manufactured by hot working grade RVA graphite which is characterized by a bulk density of 1.84 g/cc under pressures as high as 3500 lb/in.^{2} and temperatures up to 3000°C. The physical properties of a 30-inch diameter ZTE graphite billet are tabulated along with the properties of RVA graphite. (auth)

24957 (WANL-PR(P)-006) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Sixth Quarterly Report, September 21, 1964-December 20, 1964. G. G. Lessmann and D. R. Stoner (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS 3-2540. 58p. (NASA-CR-54301; N65-20885). $3.00(CFSTI).

The procurement phase of this program is essentially complete. The sheet butt weld parameter study has been completed for all available niobium and tantalum alloys and for W-25Re EB welds. Bend test results for alloys not previously reported are included. These include TIG welds in AS-55, T-111, and T-222 and EB welds in these and C-129Y and B-66. A summary of current bend test results are given. The bead-on-plate weld restraint patch test was run on T-111, T-222, and AS-55. These welds were defect free as determined by visual, radiographic, and penetrant inspections. The first series of butt welds in $\frac{3}{8}$ inch plate was bend tested. Included were transverse and longitudinal specimens of Ta-1OW, SCb-291, Cb-752, C-129Y, D-43, B-66, and FS-85. Both transverse and longitudinal specimens of Ta-1OW, FS-85, and SCb-291 displayed excellent ductility although the longitudinal specimens for FS-85 and SCb-291 failed at 125° and 160° bend angles respectively. The longitudinal specimen of C-129Y was bent through 132° without failure but the transverse specimen failed at 27°. Other alloys had poorer ductility. Helium gas samples of the backfilled weld box were again taken and, using the technique of cryogenic concentration of impurities, were analyzed on a mass spectrometer. The oxygen concentration level in the as-backfilled chamber was found to be less than 0.25 ppm with a total active impurity concentration of less than 1.25 ppm. A specially procured ultrahigh purity helium was used in this test. This grade is being used for all welding on this program. (auth)

24958 PRODUCTION PROCESSES AND PROPERTIES OF SUPERCONDUCTOR WIRES DESTINED FOR SOLENOIDS PRODUCING INTENSE MAGNETIC FIELDS. M. O. Smulkowski. Bull. Soc. Franc. Electriciens (8), 5: 640-3 (Oct. 1964). (In French)

Since the discovery of superconductors of the second type, in which the critical magnetic fields are very high, the construction of superconducting solenoids has undergone considerable development. The principal advantages of superconducting properties in solenoids are indicated. The principal difficulties in the utilization and preparation of such materials are also discussed. (tr-auth)

24959 A TECHNIQUE FOR POWDER-ROLLING TUNGSTEN AND TUNGSTEN-45 v/o UO_2 DISPERSIONS. T. J. Ready and H. D. Lewis (Los Alamos Scientific Lab., N.

Mex.). Intern. J. Powder Met., 1: No. 2, 56-63(Jan. 1965). (LA-DC-6671)

Investigation of the many interrelated variables affecting the precision powder-rolling of a refractory metal nuclear fuel element material led to the successful preparation of W and W-45 v % UO_2 dispersion-alloy strip. Either the W or the W-UO_2 strip can be produced in continuous lengths of over 6 ft, widths up to 3½ in., and thicknesses up to 0.060 in., using the Stanat TAL-600 mil. The successful powder-rolling technique is based on modifications of the basic rolling-mill equipment, especially in the treatment of the roll faces. The rolling-mill modifications, auxiliary equipment, and rolling conditions necessary for the powder-rolling of refractory materials into strips of high quality are described. (P.C.H.)

24960 GROWTH OF γ-TUNGSTEN OXIDE WHISKERS BY VAPOR DEPOSITION. E. G. Wolff (Avco Corp., Wilmington, Mass.). J. Am. Ceram. Soc., 48: 221-2(Apr. 21, 1965).

An apparatus for growing $W_{18}O_{49}$ needle crystals up to 10 mm in length is described. Argon gas saturated with water vapor flowed through a surrounding 20-liter bell jar. A tungsten susceptor cup was heated about 1 hr to 1200°C, then started to sink in MgO insulation powder, and heated more rapidly. At 1600°C red-violet needles began to grow radially downward at angles of 20 to 45° from the upper sides of the cylindrical cavity left by the sinking tungsten cup. Electron and x-ray diffraction studies indicated that the needles were $W_{18}O_{49}$. (M.C.G.)

24961 THE QUANTITATIVE ELECTRODEPOSITION OF TRACER PROTACTINIUM. G. Smith and G. A. Barnett (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Inorg. Nucl. Chem., 27: 975-8(May 1965).

The electrodeposition of Pa was studied using α-active ^{231}Pa and βγ-active ^{233}Pa tracers. It was demonstrated that quantitative and adherent deposition of ^{231}Pa is obtained on stainless steel from any one of the following electrolytes: 0.25 M ammonium fluoride; 0.015 M ammonium fluoride – 0.25 M ammonium chloride; and 0.02 M oxalic acid – 0.06 M nitric acid. The use of 50 μg of natural uranium as carrier and co-deposit is recommended. A positive bias was found for electrodeposited sources of ^{231}Pa on platinum and steel when compared to the best pipetted values on platinum. The necessary purification of ^{233}Pa from parent ^{237}Np, and of ^{231}Pa from its extensive daughter chain, is simply effected by extraction into TTA/xylene from 10 M nitric acid. (auth)

24962 SINTERING AND DENSIFICATION STUDIES ON BeO POWDERS. D. T. Livey and A. W. Hey (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 285-93(1964). (AERE-R-4447)

The results of a general study of the sintering and densification properties of a number of beryllia powders are presented and discussed. A wide variation in the densification behavior of powder compacts was observed and was found, for particular cases, to be related to the presence of one or more impurities. High impurity content was associated with poor densification behavior. Diffusion coefficients calculated from measurements of sintering kinetics are reported for pure and impure material. A higher diffusion coefficient was associated with the powder of high impurity content. Activation energies for densification were obtained in the range from 100 to 140 kcal/mole. Further studies are reported on surface area and permeability measurements made on compacts at different stages in the sintering cycle. Extensive changes, with little corresponding change in density, were found for the powders with poor densification behavior. A simultaneous study of the loose powders showed that their characteristics were reflected in the densification behavior of compacts. An attempt was made to form a rationalized picture of the behavior of the powders under the particular experimental conditions used and further experiments to achieve very high density with the impure material are reported. (auth)

24963 EFFECTS OF POWDER CHARACTERISTICS, ADDITIVES AND ATMOSPHERE ON THE SINTERING OF SULFATE-DERIVED BeO. W. W. Beaver, J. G. Theodore, and C. A. Bielawski (Brush Beryllium Co., Cleveland). J. Nucl. Mater., 14: 326-37(1964).

The factors affecting densification during sintering of sulfate-derived BeO to obtain high-purity, high-density nuclear hardware were studied and correlated. The studies included the effects of crystallite size, residual SO_3 content, the nature of furnace atmosphere, the presence of impurities and additives, as well as the influence of processing variables such as time and temperature of sintering and the amounts and nature of binders and lubricants. Factors tending to inhibit sintering were: large crystallite size (>1200Å), high residual SO_3 content (>1% SO_3), presence of water vapor from any source, and the presence of organic additives. The main factor promoting densification during sintering was the presence of additives that increase diffusion rates. Fe_2O_3 was most effective in this regard but MgO, CaO, and ZnO also produced noticeable effects, particularly at the lower sintering temperatures (<1525°C). Al_2O_3 and UO_2 aided densification at higher temperatures. (auth)

24964 DIFFUSION BONDING OF HIGH TEMPERATURE ALLOYS. A. Toy (North American Aviation, Inc., Los Angeles, Calif.). Metals Park, Ohio, American Society for Metals, 1964, Technical Report No. W 4-3.4, 12p. $3.00. (CONF-540-5)

From American Society for Metals Western Metal and Tool Conference, Los Angeles, Mar. 1964.

Some controlling factors of the diffusion bonding process and their effects on the metallurgical and mechanical properties of the bond are discussed in general terms. Specific examples of experimental results obtained from the studies of HS-25 cobalt alloy, Nb-752 niobium alloy, and Ti-6Al-4V titanium alloy are given. Structural components successfully bonded from various alloy systems are presented to illustrate the versatility of the diffusion bonding process. The author is senior research engineer, North American Aviation, Inc., Los Angeles Division. This paper is scheduled for presentation in the Joining Development Session of the 1964 Western Metal and Tool Conference, Los Angeles. (auth)

24965 THE NEWER PRECIPITATION HARDENING STAINLESS STEELS. Marcus W. Marshall (Armco Steel Corp., Middletown, Ohio). Metals Park, Ohio, American Society for Metals, 1965, Technical Report No. W 10-4-65, 9p. $3.00. (CONF-650215-2).

From American Society of Metals Western Metal Congress, Los Angeles.

The development of precipitation hardening (PH) stainless steels is discussed. Advances made in the metallurgy of PH stainless steels are described. Research studies were carried out, which provided a better understanding of the effect of minor chemical elements on fracture toughness both at elevated and cryogenic temperatures. The significance of close analytical control was established and the advantages of both single and double vacuum methods over conventional air melting are considered. (auth)

24966 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL COMPOSITIONS. David William Savage (to United Kingdom Atomic Energy Authority). British Patent 976,950. Dec. 2, 1964. Filed Nov. 5, 1962.

A method is described for the preparation of nuclear fuel compositions including coated particles of fissile material dispersed in a graphite matrix. The matrix contains a proportion of graphite powder having a continuous size distribution all <120 mesh, a proportion of fine powder (30–40 wt %) of average particle size ~1μ, and the thermal decomposition products of a carbonizable binder such as pitch, phenyl formaldehyde, or furfuryl alcohol. The coated particles have core sizes in the range of 200–500μ and a coating thickness of 40–150μ. The coated particles, graphite matrix, and a solvent for the binder contained in the graphite are mixed together; and the solvent is then evaporated prior to formation of the artifact by either hot extrusion or pressing. The artifact is baked slowly in an

inert atmosphere to 850°C and then baked to 2000°C. (B.L.M.)

24967 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Edward Jeffrey Wynne (to United Kingdom Atomic Energy Authority). British Patent 977,149. Dec. 2, 1964. Filed Nov. 29, 1961.

A method is proposed for pressure welding as well as fusion welding the end caps of a nuclear fuel element in which the rod of metallic U is contained in a hollow open-ended cylinder, the ends of which are closed by plugs or caps welded in place. The open-ended cylinder and end caps are made of a magnesium alloy. The open ends of the container are shaped to produce a region of frusto-conical form, and the end caps are similarly shaped to provide surface contact between the outer surface of the end cap and the inner surface of the cylinder. The registered parts of the container and end cap are co-extruded hot to cause the frusto-conical portions to become cylindrical in shape. (B.L.M.)

24968 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. (to Mitsubishi Atomic Power Industries, Inc.). British Patent 978,263. Dec. 23, 1964. Priority date Feb. 12, 1960, Japan.

A method of manufacturing a nuclear fuel element comprises filling a cladding tube with powdered fuel material, closing its ends, subjecting the tube to a number of cold swaging operations, and finally subjecting the tube to a hot swaging operation. The cold swaging operations, each of which causes a reduction in the cross-sectional area of the tube of not more than 8% of the cross-sectional area preceding the operation, are continued progressively until the bulk density of the fuel material within the tube reaches a value above which the wall of the cladding tube is decreased in thickness. Subsequently, the cold swaged tube is subjected to one or more cold swaging operations to increase the bulk density of the fuel to its maximum possible value. (B.L.M.)

24969 IMPROVEMENTS IN OR RELATING TO BROACHING TOOLS. Leslie James Groves and Eric Smith (to United Kingdom Atomic Energy Authority). British Patent 978,446. Dec. 23, 1964. Filed Apr. 19, 1962.

A tool is described for broaching preformed channels in graphite, e.g., nuclear graphite or like materials, that includes a broaching head adpated for insertion into the preformed groove to present a cutting face to a part of the channel wall. The cutting face is formed at the base of a part conical member mounted between blade-like supports. The tool is particularly applicable to broaching the base of grooves milled in elongated sections of graphite and finds application in the formation of keyhole section grooves. (B.L.M.)

24970 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF FUEL MATERIALS FOR NUCLEAR REACTORS. Ronald George Sowden (to United Kingdom Atomic Energy Authority). British Patent 978,615. Dec. 23, 1964. Filed Aug. 18, 1961.

A method is reported for the production of a mixture of U and Pu oxides by precipitation as the oxalates of U(IV) and Pu(III) and calcination of the oxalate precipitate. Electrolytic reduction of a solution containing uranyl and Pu(IV) ions prior to precipitation of the reduced metal oxalates is effected using a Pt or Tl anode. The calcined precipitate may also be reduced to the dioxides. The precipitation and separation of the oxalate may be continuously effected. (B.L.M.)

24971 FABRICATION OF NUCLEAR REACTOR FUEL ELEMENTS. Herbert Noel Jones and Ian Cochran (to United Kingdom Atomic Energy Authority). U. S. Patent 3,153,280. Oct. 20, 1964. Priority date Feb. 10, 1960, Great Britain.

A process for the manufacture of nuclear fuel elements is reported whereby the protective sheath is subjected to external pressurization at elevated temperature in order to form the sheath into intimate contact with the fissile member. The protective sheath is subjected to an initial compressive stress by applying opposing forces to opposite ends of the sheath. The opposing forces are applied by a clamping member constructed in two parts of different materials joined end to end so as to have a longitudinal thermal expansion substantially equal to that of the fuel member. The opposing forces are progressively relieved to allow the sheath to elongate substantially by only the same amount as the fuel member on heating during pressurization. (B.L.M.)

24972 NUCLEAR REACTOR FUEL ELEMENTS. Alan Frederick Taylor and James Thomas Stockdale (to United Kingdom Atomic Energy Authority). U. S. Patent 3,158,929. Dec. 1, 1964. Priority date Aug. 4, 1960, Great Britain.

A process is patented for effecting an annular weld between a thin-walled cylindrical nuclear fuel element sheath and a thin-walled cylindrical end cap for the sheath having adjacent butting side edges and substantially flush end edges. A U-shaped annular weld groove that extends inwardly from the flush end edges is machined in adjacent butting edges of the sheath and end cap. The combined thickness of the walls of the end cap and sheath in the vicinity of the groove is ~0.120 in., and the maximum width of the groove is ~0.080 in. with a maximum depth of ~0.070 in. The annular weld between the butting edges is made under a blanket of inert gas by relatively moving a non-consumable electrode around the annular U-groove with the tip of the electrode below the top of the groove. (B.L.M.)

24973 ELECTRON BEAM WELDING PROCESS. Harold M. Cobb (to United Nuclear Corp.). U. S. Patent 3,161,950. Dec. 22, 1964. Filed Apr. 1, 1960.

A method is described for forming a corrosion-resistant composite metal element having an outer layer of Zr and a metallurgically bonded inner layer. An enclosure is formed of at least two mating parts of Zr and assembled about a core material that closely conforms to the interior of the enclosure. The assembly is placed in a high-vacuum environment, and the enclosure is welded together by directing a beam of high-energy electrons along the line of joining of the enclosure parts. The welded assembly is subjected to high pressure at an elevated temperature, and foreign substances are removed from the surface by wet blasting with a slurry of water and particles of aluminum oxide. (A.G.W.)

24974 METHODS OF PRODUCING CARBON–IMPREGNATED ARTEFACTS. Kenneth Wallace Carley-Macauly and Malcolm MacKenzie (to United Kingdom Atomic Energy Authority). U. S. Patent 3,164,487. Jan. 5, 1965. Priority date Apr. 26, 1960, Great Britain.

An artefact of high open porosity and low thermal conductivity is arranged in an atmosphere of hydrocarbon gas. An initial zone of the artefact is heated to a temperature within a range in which carbon is deposited from gas permeating the artefact until the initial zone is fully impregnated. The temperature of the impregnated zone is then raised progressively to maintain the deposition temperature within an advancing boundary zone, the rate of rise of temperature being so controlled that the advancing boundary zone is fully impregnated. The resultant artefacts have very low permeability to gases. The method may be used for producing artefacts containing fissile materials suitable for use as reactor fuel elements. (A.G.W.)

24975 METHODS OF FORMING METAL CARBIDE SPHEROIDS WITH CARBON COAT. Walter V. Goeddel (to U. S. Atomic Energy Commission). U. S. Patent 3,179,723. Apr. 20, 1965.

A method was developed for making pyrolytic carbon coated metal carbide particles having increased thermal stability. A mixture of the metal of the carbide to be formed, carbonizable binder, and carbon sufficient to yield a solution of carbon in the resultant carbide in excess of the saturation concentration at elevated temperatures is converted into particles. These particles are then heated in a bed of finely divided graphite above the carburizing temperature and then above the melting point to spheroidize the particle. The spheroidized particles

are then heated in a gaseous hydrocarbon atmosphere to form a pyrolytic carbon coating thereon. (AEC)

Properties and Structure

Refer also to abstracts 25052, 25619, and 25622.

24976 (AD-612759) MECHANICAL AND PHYSICAL PROPERTIES OF TZM MOLYBDENUM ALLOY SHEET AND OF TUNGSTEN SHEET. Quarterly Progress Report No. 9, December 1, 1964–March 1, 1965. Paul G. Adams and Clifford L. Dotson (Southern Research Inst., Birmingham, Ala.). Mar. 19, 1965. Contract N600(19)59530. 38p. $2.00(CFSTI).

Measurements made of the mechanical and physical properties of TZM molybdenum alloy included: bend-transition temperature in the longitudinal and transverse directions of recrystallized and coated 0.040-in. sheet; room-temperature compression in the longitudinal and transverse directions in the optimum condition and recrystallized 0.040-in. sheet; and elevated-temperature unnotched-tensile properties at 1200 and 2000°F in the longitudinal direction of 0.016-, 0.020-, 0.040-, and 0.060-in. optimum condition sheet. The elevated-temperature compression properties of tungsten sheet of 0.020-, 0.060-, and 0.100-in. thickness and at selected temperatures between 600 to 1800°F were determined. (W.L.G.)

24977 (AFML-TR-65-2(Pt.I, Vol. I)) TERNARY PHASE EQUILIBRIA IN TRANSITION METAL–BORON–CARBON–SILICON SYSTEMS. PART I. RELATED BINARY SYSTEMS. VOLUME I. Mo–C SYSTEM. E. Rudy, St. Windisch, and Y. A. Chang (Aerojet-General Corp., Sacramento, Calif. Materials Research Lab.). Dec. 1964. Contract AF33(615)-1249. 164p.

A complete phase diagram of the system molybdenum–carbon is presented. A thermodynamic model for the description of the phase separation of the Me_2C phases in transition metal–carbon systems has been developed and was semiquantitatively applied to Mo_2C. Literature data on thermodynamic properties of molybdenum carbides have been critically evaluated and data were selected. Apparative techniques for the precise study of phase reactions at high temperatures are described. (auth)

24978 (AROD-2884.3) FABRICATION AND FRACTURE OF POLYCRYSTALLINE NiO. Third Interim Technical Report. W. B. Harrison (Honeywell Research Center, Hopkins, Minn.). Mar. 1965. Contract DA-11-022-ORD-3441. 48p.

High purity, sub-micron NiO powders were obtained by the preparation and pyrolysis of nickel oxalate. The grain growth and densification of these submicron particles was studied under various sintering atmospheres and under various hot pressing conditions. Sintering produced 6–17 μ NiO with a density as high as 96% of its theoretical x-ray density of 6.805 g/cc. Such material in the as-machine state had a zero transverse strength of 23,700 psi. Localized concentrations of grain boundary porosity appeared to be the source of failure in sintered NiO. Hot pressing produced 2μ NiO with less than 2% porosity. When a closed pore state was reached at about 3.5% porosity, gases were entrapped within the NiO which expanded and apparently introduced grain boundary microcracks into the NiO structure. Such material fractured at stresses as low as 5,000 psi at room temperature. The heat treatment of such material removed these stresses and increased its strength to as high as 18,300 psi. Mechanical polishing increased the room temperature strength to 23,000 psi and its 650°C strength to 24,400 psi. No evidence for a rhombohedral transformation in this fine-grained, polycrystalline NiO was observed. (auth)

24979 (AROD-2884.4) MECHANICAL BEHAVIOR OF POLYCRYSTALLINE CERAMICS. Final Report. W. B. Harrison (Honeywell Research Center, Hopkins, Minn.). Apr. 1965. Contract DA-11-022-ORD-3441. 15p.

The fabrication of high-density, high-purity, fine-grained polycrystalline MgO, NiO, and TiC ceramics from micron and sub-micron powders by sintering and hot pressing techniques is discussed. The influence of pore size, pore location, grain size, surface damage, grain boundary condition, and certain impurities on the room temperature fracture behavior of these cubic materials is summarized. Fracture behavior studies on chemically polished, polycrystalline MgO were made to 1200°C for various types of microstructures. Some ductility in certain high density MgO structures was observed at temperatures as low as 800°C and progressively more ductility occurred at the higher temperatures. Certain electrical behavior in NiO and TiC was studied and, in the case of TiC, a preliminary correlation with mechanical behavior was made. (auth)

24980 (COO-987-4) DEFECT PHASES IN ALLOYS. Final Report. (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-987. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Investigations into the previously reported anomalously high vacancy concentrations in aluminum alloys have led to the conclusion that no primary solid solution is defective and that known defect phases are all intermediate phases. A thin-film transmission election microscope study was made of β-nickel–aluminum alloys. Dislocation configurations were examined and tentative explanations advanced for the hardening of non-stoichiometric alloys. (W.L.G.)

24981 (CU-2660-16) HIGH-TEMPERATURE THERMAL PROPERTIES OF GASES AND VAPORS. Progress Report, 1964/65. Charles F. Bonilla (Columbia Univ., New York. Dept. of Chemical Engineering). Mar. 1965. Contract AT(30-1)-2660. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A capillary viscometer was developed for alkali metal vapors. Progress on the critical-region physical properties of rubidium and other alkali metals is reported. An apparatus for the measurement of high-temperature surface tensions is described, and some results are reported for potassium. Work on the thermodynamic properties of the K–Hg system is described. Some results of a study of thermal and electrical interfacial resistances of Hg vs stainless steel are discussed briefly. Work was done on the effects of scratches and strips on boiling in tubes. (D.L.C.)

24982 (EURAEC-1270) ZIRCONIUM ALLOYS. Final Report No. 1, April 1, 1962–March 31, 1964. R. Syre, A. Guilhaudis, J. Orsag, M. Croutzeilles, R. Bourbon, and J. Bonmarin (Compagnie Pechiney, Paris (France)). July 1964. Work was Performed under United States–Euratom Joint Research and Development Program. Contract 067-62-4 RDF. 153p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

This study reviews the eutectoid alpha alloys of zirconium containing vanadium or nickel additions. Hardening of these alloys is brought about by rapid breakdown of the beta phase and appearance of the fine dispersed compounds ZrV_2 or Zr_2Ni as well as by the addition of soluble elements such as aluminum, titanium or tin in the alpha phase. The compound Zr_2Ni does not cause any substantial hardening. The compound ZrV_2 has a much more intensive hardening effect. Aluminum and titanium proved highly deleterious from the standpoint of resistance to corrosion in steam. The ternary addition of tin up to contents of 4 wt % leads to good mechanical properties in both the cold and the hot state up to 500°C and good thermal stability after 3,000 hours at 500°C; the corrosion of the Zr–V–Sn alloys in water or steam depends on the distribution of the compound ZrV_2 in the matrix and on the test temperature. At 350 and 400°C, the corrosion rate remains greater than that of zircaloy-2. At 480°C, the oxide layer remains appreciably more adherent. The hydrogen pick-up rate during corrosion is about one-fifth of that observed in zircaloy-2. The general characteristics of the most promising alloy, containing 1.5% V + 1.5% Sn, are given. (auth)

24983 (IS-T-9) THE RESISTIVITY OF MOLTEN Bi–Sn ALLOYS (thesis). Fred Yet Lieu (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 72p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The resistivity of the molten Bi–Sn system was determined by the conventional four-probe technique with a precision of 0.42%. The resistivity of the pure components

and their alloys is a linear function of temperature over the range of temperature from 230 to 550°C. The resistivity is a linear function of concentration from zero to 90 at. % Bi for 300°C, and from 5 to 80 at. % Bi for 500°C. The Bi–Sn system was found to approximately obey Matthiessen's rule at low bismuth concentration. Results from a calculation show that the deviation from this rule is small, and the deviation so calculated is in good agreement with that calculated from solid state measurements. Present results do not agree with the results predicted by the Takeuchi theory on the concentration dependence of resistivity. The resistivity anomalies in the Bi–Sn system observed by Roll were not found. The electrodeless technique was shown to have questionable accuracy. (auth)

24984 (KAPL-3088) FRACTURE-TOUGHNESS DETERMINATIONS OF A302-B AND Ni–Mo–V FORGING STEEL WITH VARIOUS-SIZED SPECIMENS. PART II. D. F. Mowbray and K. Minassian (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 15, 1964. Contract W-31-109-eng-52. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Plane-strain fracture-toughness measurements were made on normalized A302-B steel and a brittle Ni–Mo–V forging steel. Specimens tested included a 0.4-in.-thick single-edge-notched specimen and notched-bend specimens with cross sections as large as 6.0-in. square. The single-edge-notched specimen was used because of its potential use in studying properties of irradiated steel; the large bend specimens were used because of their capability for measuring much higher values of fracture toughness. The test data obtained supplement those from an earlier investigation of a quenched and tempered A302-B steel and the same Ni–Mo–V steel. The valid plane-strain fracture-toughness data obtained for all three steels are plotted as a function of temperature. The temperature dependence of plane-strain fracture toughness for these steels is discussed, and a correspondence with fracture-specimen shear-lip thickness is demonstrated. (auth)

24985 (LA-3233) AN INTEGRATED SERIES OF CRYSTALLOGRAPHIC COMPUTER PROGRAMS. III. COMPARISON OF EQUIVALENT REFLECTIONS. R. B. Roof, Jr., D. T. Cromer, and A. C. Larson (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 1964. Contract W-7405-eng-36. 33p. Dep.; $2.00(CFSTI).

The procedures employed and the computer program used to compare and average the experimental intensities obtained for crystallographic equivalent reflections are described. The program performs this comparison for data in any of the 230 space groups. Output is a magnetic tape containing an asymmetric unit of data. This tape may be further used in a Fourier Series Analysis (report IV of the series) or a General Least-Squares Refinement (report V of the series) of the crystal structure. (auth)

24986 (MLM-1220) REACTOR FUELS AND MATERIALS DEVELOPMENT; PLUTONIUM RESEARCH: JULY–SEPTEMBER 1964. L. J. Wittenberg and G. R. Grove (Mound Lab., Miamisburg, Ohio). Sept. 30, 1964. Contract AT-33-1-GEN-53. 28p. Dep.; $2.00(cy), 1(mn) CFSTI.

Phase studies were conducted on Pu–Ce–Fe, Pu–Ce–Ni, Pu–Ce–Ni–Co–Cu, Pu–Pt, Pu–Cu, and Ce–Pt systems. The phase transformations in high-purity plutonium and the boron crystal structure were also studied. The thermal diffusivity of UC, the densities of liquid Pu–Ce–Co and Pu–Ga alloys, and the viscosities of Pu–Ce–Co alloys were measured. (W.L.G.)

24987 (RFP-506) DELTA-STABILIZED TERNARY ALLOYS OF PLUTONIUM. J. E. Fuller (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Apr. 22, 1965. Contract AT(29-1)-1106. 22p. Dep.; $2.00(CFSTI).

A preliminary survey of the plutonium rich-corners of the Pu–Al–Ga, Pu–Zn–Ga, and Pu–Ce–Ga systems was made. Emphasis was placed on the determination of how well the delta phase of plutonium was stabilized by these alloy additions. (auth)

24988 (SWRI-1228-51) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. 1. CYCLIC PRESSURE TESTS OF LARGE SIZE PRESSURE VESSELS. 2. LOW CYCLE FATIGUE TESTING OF ONE-HALF SCALE MODEL PRESSURE VESSELS. 3. EFFECT OF WELD DEFECTS ON THE FATIGUE STRENGTH OF A302B STEEL. Progress Report No. 12. A. G. Pickett, S. C. Grigory, and A. R. Whiting (Southwest Research Inst., San Antonio, Tex.). Jan. 18, 1965. Contract AT(11-1)-1228. 41p. (SWRI-1228-52; SWRI-1228-53) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

24989 (TID-21673) FUNDAMENTAL STUDIES IN HIGH-TEMPERATURE MATERIALS PHENOMENA. SCOPE I. HIGH-TEMPERATURE-PRESSURE PHYSICAL PROPERTY MEASUREMENTS. SCOPE II. ELECTRICAL RESISTIVITY MEASUREMENTS OF MATERIALS IN RELATION TO HIGH-TEMPERATURE TRANSFORMATIONS. SCOPE III. TRANSFORMATIONS IN AB_2 INTERMETALLIC COMPOUNDS. Annual Progress Report. (Pennsylvania State Univ., University Park. Materials Research Lab.). [1964]. Contract AT(30-1)-2581. 123p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Summaries are presented of progress in the measurement of properties of high-temperature materials. Dielectric, magnetic, spectroscopic, elastic properties, phase, and electrical resistivity studies were made on selected ceramic materials. Thermal analyses and crystal structure studies were made on the intermetallic compounds of the rare earths with zinc. (W.L.G.)

24990 (UCRL-12357(Rev.I)) SOME MECHANICAL PROPERTIES OF URANIUM–10 WT% MOLYBDENUM ALLOY UNDER DYNAMIC TENSION LOADS. K. G. Hoge (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 25, 1965. Contract W-7405-eng-48. 46p. Dep.; $2.00(cy), 1(mn) CFSTI.

Dynamic tensile tests were conducted on uranium–10 wt% molybdenum alloy in as-cast and wrought conditions. Carbon content was varied from 71 to 800 ppm. Heat treatment was also varied. Tests were conducted on a universal testing machine at strain rates of 4.8×10^{-5} and 0.057 in./in./sec and on a modified Dynapak at strain rates up to 100 in./in./sec. Tests were run from 75 to 600°F. Relatively low strain rates were used to determine the susceptibility to stress corrosion while the higher strain rates demonstrated the sensitivity of various mechanical properties to strain rate effects. (auth)

24991 (UCRL-12405) ENGINEERING APPLICATION OF WEIBULL STATISTICS. E. Y. Robinson (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 16, 1965. Contract W-7405-eng-48. 48p. (CONF-650607-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

For presentation at American Society of Mechanical Engineers, Berkeley.

The Weibull theory is an attempt to account for the variability of measured strength in "brittle" material. It is not of general applicability although there are many cases where the theory is satisfactorily confirmed by experimental evidence. Its qualitative aspects are frequently confirmed. Even in its simplest form, the theory may be used to approximate fairly complex data and is amenable to the development of conservative but meaningful design rules. Some methods are reviewed for analyzing data in terms of the Weibull distribution, and a convenient normalized expression is given. Formulas are given for the statistical behavior of the weakest specimens in a given sample and the application is demonstrated using data on beryllia and alumina. Brief consideration is given to proof-test (truncation) and bias (pre-stress or axis-shift) and the effects on a "primitive" (unbiased, untruncated) sample. (auth)

24992 (UNC-5094) CARBIDE FUEL DEVELOPMENT. Progress Report, October 1, 1963 to June 30, 1964. A. Strasser and D. Stahl (United Nuclear Corp., White Plains, N. Y. Development Div.). Sept. 9, 1964. Contract AT(30-1)-2899. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The melting (liquidus) temperature of $(U_{0.95}Pu_{0.05})C_{0.98}$ was determined to be 2535 ± 20°C; the solidus temperature was estimated to be 2500 ± 20°C. The vapor pressures of U and Pu over $(U_{0.95}Pu_{0.05})C_{0.98}$ were measured by the Knudsen effusion technique. Pu vaporized at a higher rate

than the U. The U vapor pressure over (UPu)C was similar to that of U over UC. Post-irradiation examination of the Nb cladding and specimen parts which had been in contact with $(U_{0.8}Pu_{0.2})C_{0.95}$ fuel revealed that no reactions had occurred after 3270 hrs at 795°C. Niobium specimen parts did not react after 3270 hrs at 1000°C, however, carburization was noted at slightly higher temperatures. A post-irradiation examination of four clad $(U_{0.8}Pu_{0.2})C_{0.95}$ specimens irradiated with a greater dosage disclosed that the fuel was stable, fission gas release was low (1.5% max), dimensional changes relatively small (up to 5% vol increase), and the microstructure was essentially unchanged. No significant differences were noted in the behavior of fuel with or without a Ni sintering aid. The Nb-clad specimens were sound, their dimensions did not change, and no incompatability was discovered. Stainless steel-clad specimens were ruptured by longitudinal brittle cracks. The ruptures are believed to be the result of a drastic, high temperature decrease in the steels ductility to a level below that required to accommodate the fuel expansion strains. The type 316 stainless steel cladding operated at 760°C maximum for 3270 hrs. The decrease in ductility probably resulted from high temperature irradiation in a thermal neutron flux. The cladding did not react with the fuel at points of tight contact, however, reactions occurred in the cladding opposite fuel pellet interfaces and cracks. Evidence to date indicates the reaction to be a transfer of U and Pu to the cladding by Na which had entered the specimens after the rupture. No correlation of the reacted zones with the rupture was evident. (W.L.G.)

24993 (Y-889) SELECTED PHYSICAL PROPERTIES OF MERCURY IN THE TEMPERATURE RANGE 100 TO 1000°C. A Literature Search. Frances Sachs (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 10, 1952. Contract W-7405-eng-26. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

About 80 annotated references are presented on the density, heat capacity, surface tension, thermal conductivity, vapor pressure, and viscosity of mercury at 100 to 1000°C. An author index is included. (D.L.C.)

24994 EQUIATOMIC COMPOUNDS OF THE TRANSITION AND LANTHANIDE ELEMENTS WITH Rh, Ir, Ni AND Pt. A. E. Dwight, R. A. Conner, Jr., and J. W. Downey (Argonne National Lab., Ill.). Acta Cryst., 18: 835-9 (May 10, 1965).

Crystal structure and lattice parameter data are reported for a number of new intermetallic compounds between an element of the Sc (including the lanthanides), T:, V, or Cr group and an element of the Co or N: group of the Periodic Table. Representatives were found of the orthorhombic B19, B_f, and B27 and the cubic B2 structures. (P.C.H.)

24995 NEUTRON AND X-RAY DIFFRACTION STUDY OF LiRh. S. S. Sidhu, K. D. Anderson, and D. D. Zauberis (Argonne National Lab., Ill.). Acta Cryst., 18: 906-7 (May 10, 1965).

A study of the crystal structure of LiRh was made by combined neutron and x-ray diffraction techniques to determine unambiguously the positions of lithium atoms in the unit cell. The unit cell is hexagonal; space group $P\bar{6}$; $a_0 = 2.649 \pm 0.003$, $c_0 = 4.357 \pm 0.002$ Å, with one Rh at (0,0,0) and one Li at ($\frac{1}{3}$, $\frac{2}{3}$, $\frac{1}{2}$), and calculated density Q = 6.88 $g.cm^{-3}$. Rh atoms are in one layer and Li in the other, the layers alternating along the c axis at $c_0/2$ distance apart. The interatomic distances are Rh–Rh = 2.649, Li–Li = 2.649, and Rh–Li = 2.663 Å. (auth)

24996 THE STRUCTURE OF Nb_6Sn_5. J. R. Ogren, T. G. Ellis, and J. F. Smith (Ames Lab., Ames, Iowa). Acta Cryst., 18: 968-73(May 10, 1965). (IS-903)

The crystal structure of the intermetallic compound Nb_6Sn_5 was determined. The space-group symmetry was found to be Immm (D_{2h}^{25}), and lattice parameters were measured as a = 5.656 ± 0.002, b = 9.199 ± 0.003, c = 16.843 ± 0.004 Å. The compound shows pronounced layering normal to the short axis. (auth)

24997 STAINLESS STEEL WITH HIGH-CAPTURE CROSS SECTION FOR THERMAL NEUTRONS. I. S. Lupakov and N. A. Vasil'ev. At. Energ. (USSR), 18: 242-5(Mar. 1965). (In Russian)

Technological and mechanical characteristics of a new austenitic stainless steel EP-229 (X17G21H15T) with relatively high cross section for thermal neutrons are described. The steel resistance against general and intracrystalline corrosion in a steam–water media and stability of the structure at continuous elevated temperatures were investigated. The steel can be used instead of nickel or X18H10T type steel in reactor construction. (tr-auth)

24998 THERMOMAGNETIC EFFECTS IN PYROLYTIC GRAPHITE. J. J. Mills, R. A. Morant, and D. A. Wright (Univ. of Durham, Eng.). Brit. J. Appl. Phys., 16: 479-85(Apr. 1965).

The electrical conductivity, magnetoresistance, thermal conductivity, and Nernst coefficient were measured between 60 and 300°K for samples cut from a bar of pyrolytic graphite. The effective formation temperatures for the samples varied from 2300 to 3020°C. The experimental values of the Nernst coefficient Q agree quite well with theory, with a mean value Q = 2.7 (k/e) μ at room temperature. This value, combined with the fact that Q is independent of μB over a wide range, indicates that boundary scattering is important compared with lattice scattering. The results indicate poor prospects for Ettingshausen cooling. (auth)

24999 AN INVESTIGATION OF THE HEAT PULSE METHOD FOR MEASURING THERMAL DIFFUSIVITY. R. Taylor (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). Brit. J. Appl. Phys., 16: 509-15 (Apr. 1965).

The heat pulse method for determining thermal diffusivity α is investigated to ascertain if it can be applied to determine thermal conductivity changes of graphite and ceramics under neutron irradiation. It is verified that heat losses and a finite pulse time effect alter the temperature–time curve for the specimen rear face. The variation of the parameter ω in the relation $\alpha = \omega L^2/\pi^2 t_{\frac{1}{2}}$ is determined experimentally for $t_{\frac{1}{2}}$ values in the range 0.002 to 16 sec. When a considerable heat loss occurs, a reliable diffusivity value can still be obtained from the relation $\alpha = 0.48\ L^2/\pi^2 t_x$ by measuring t_x, the time axis intercept at zero temperature rise. (auth)

25000 THE THERMOMAGNETIC FIGURE OF MERIT OF REHEATED PYROLYTIC GRAPHITE AT LIQUID HELIUM TEMPERATURE. H. J. Goldsmid and D. E. Lacklison (General Electric Co. Ltd., Wembley, Middx, Eng.). Brit. J. Appl. Phys., 16: 573-5(Apr. 1965).

The dimensionless thermomagnetic figure of merit $z_E T$ was determined at 4.2°K for pyrolytic graphite that was reheated to 3500°C after deposition. The magnetic field was applied along the 'c' axis. Measurements of the Nernst coefficient, electrical conductivity and thermal conductivity yielded a maximum value for $z_E T$ of 3.8×10^{-3} in a field of 500 gauss. $z_E T$ was observed to fall to 1.8×10^{-3} in a field of 5 kgauss; this observation was confirmed by measurement of the temperature depression due to the Ettingshausen effect as a function of current. The experimental values of $z_E T$ are somewhat lower than expected on the basis of Klein's simple two-band model with an energy overlap of 0.01 ev. It appears that the mean free path is greater for phonons than for charge carriers, and it is postulated that less perfect graphite may have superior thermomagnetic properties. (auth)

25001 FORMATION OF AMALGAMS OF CIS- AND TRANS-URANIDE ELEMENTS. Georges Bouissieres and Yvette Legoux (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). Bull. Soc. Chim. France, No. 2, 386-8(Feb. 1965). (In French)

After an examination of the general conditions for the formation of amalgams of Th, Pa, Pu, Am, Cm, Bk, and Cf by the action of lithium amalgam on citric solutions of the elements, the variation of the amalgam yield was given for each of the elements as a function of the initial pH of the solution. The behavior of the elements was then compared to that of the lanthanides and of actinium. (tr-auth)

25002 THE HYDROGEN REDUCTION KINETICS OF MOLYBDENUM OXIDES. J. von Destinon-Forstmann (Eldorado Mining and Refining Ltd., Ottawa). Can. Met. Quart., 4: 1-12(Jan.-Mar. 1965).

The temperatures at which the hydrogen reduction of molybdenum trioxide and molybdenum dioxide take place were established by differential thermal analysis. The kinetics of the hydrogen reduction of molybdenum trioxide were determined in the temperature range 350 to 600°C, and for molybdenum dioxide in the temperature range 600 to 850°C. It was found that the reduction of the trioxide to the dioxide, when corrected for the change in interfacial area available for reduction, follows a linear rate equation and has an activation energy of 17.6 kcal/mole. The reduction of the dioxide to the metal follows a linear rate equation without compensation for an available interfacial area, and has an activation energy of 27.4 kcal/mole. (auth)

25003 STRUCTURE OF A NEW PHASE $U_3C_3Si_2$ IN THE URANIUM-CARBON-SILICON SYSTEM. Pierre L. Blum, Philippe Guinet, and Georges Silvestre (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 260: 1911-13(Feb. 15, 1965). (In French)

From a fused ternary alloy of suitable composition, monocrystals of a new phase $U_3C_3Si_2$ could be isolated. The crystallographic study with x rays showed that this compound belongs to the orthorhombic symmetry group 1/mmm. Its cell is pseudoquadratic with the parameters $\underline{a}$ = 3.598 Å, $\underline{b}$ = 3.535 Å, $\underline{c}$ = 18.96 Å, and Z = 2. The positions of the uranium atoms were determined from the reflection intensities, those of the non-metallic elements were deduced from steric considerations. (tr-auth)

25004 CRYSTALLINE STRUCTURE OF COMPLEX HEXAFLUORIDES OF URANIUM(V) AND SILVER, POTASSIUM, AMMONIUM, RUBIDIUM, OR THALLIUM. Pierrette Charpin (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 260: 1914-16(Feb. 15, 1965). (In French)

The structure of UF_6Ag is described in a quadratic cell: $\underline{a} = 5.42_3$ Å and $\underline{c} = 7.95_9$ Å, containing two molecules. The positions of the atoms of uranium and silver were determined from the experimental intensities of the Debye-Scherrer diffractions and the positions of the fluorine atoms were deduced from geometric considerations. UF_6K, UF_6NH_4, UF_6Rb, and UF_6Tl belong to the same type of structure with an orthorhombic deformation. (tr-auth)

25005 MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF ZrO_2 STABILIZED WITH 10% Y_2O_3 BETWEEN 1000 AND 2400°K. Anne-Marie Anthony (Laboratoire des Echanges Thermiques, Bellevue, France). Compt. Rend., 26: 1936-9(Feb. 15, 1965). (In French)

Two techniques for the measurement of the electrical conductivity of ZrO_2 - 10% Y_2O_3 are described. Below 2000°K, the measurement was made in a furnace; above 2000°K the sample was heated directly by the joule effect. The results show that there is only one mechanism of conduction between 800 and 2400°K. (tr-auth)

25006 DETERMINATION OF THE SLIP SYSTEMS OF TUNGSTEN MONOCARBIDE. Jacques Corteville, Jean-Claude Monier, and Louis Pons (Institut Francais du Petrole, Rueil-Malmaison, France and Faculte des Sciences, Caen, France). Compt. Rend., 260: 2773-6(Mar. 8, 1965). (In French)

It is shown that the slip planes in tungsten monocarbide WC are the $(10\bar{1}0)$ planes. These have two minimum equivalent Burgers vectors. It was deduced that the slips occur by the two systems $[000\bar{1}]$, $(10\bar{1}0)$ and $\langle 11\bar{2}0\rangle(10\bar{1}0)$. (tr-auth)

25007 NEW TERNARY PHASES IN THE TUNGSTEN-VANADIUM-OXYGEN SYSTEM. William Freundlich (Faculte des Sciences, Paris). Compt. Rend., 260: 3077-9(Mar. 15, 1965). (In French)

The study of the W-V-O system in the composition region WV_2O_{8-x} ($0 < x \leq 2$), by thermolysis or reduction with tungsten of an equimolecular mixture of the two oxides WO_3 and V_2O_5, showed the existence of two new ternary phases: one is the quadratic ($x \simeq 0.5$) and the other is monoclinic ($0.9 < x \leq 1.1$). Some of their properties suggest the presence of compounds of the tungsten bronze type. (tr-auth)

25008 ISOTHERMAL DILATOMETRIC STUDY OF THE REACTION BETWEEN URANIUM AND GRAPHITE POWDERS. Pierre Gregoire, Pierre Azou, and Paul Bastien (Ecole Centrale des Arts et Manufactures, Paris). Compt. Rend., 260: 3080-3(Mar. 15, 1965). (In French)

The isothermal dilatometry confirms the existence of two stages, isotropic and anisotropic, of the variations of the dimensions accompanying the reaction U + C → UC in powder mixtures. It shows that the second stage appears when the reaction reaches a sufficient development. Mathematical analysis of the results leads to the description of the latter by two simple relations making it possible to determine the activation energies of the phenomena. (tr-auth)

25009 OXIDE PLASTICITY IN THE OXIDATION MECHANISM OF ZIRCONIUM AND ITS ALLOYS. D. L. Douglass (Centre d'Etude de l'Energie Nucleaire, Mol. Belg.). Corrosion Sci., 5: 255-68(Apr. 1965).

The question of how crack-free, protective oxide films can form on zirconium during oxidation when the Pilling-Bedworth ratio is about 1.5 were considered by a study of the relative plasticity of various forms of zirconia. Hot hardness measurements showed that doping monoclinic zirconia with iron, nickel, or chromium resulted in softer (more plastic) structures and that yttrium additions slightly reduced the plasticity. Calcia-stabilized cubic zirconia was found to be more plastic than monoclinic zirconia when tested at temperatures above 200°C. The behavior of anion-deficient oxides indicated that they were more plastic than stoichiometric oxides even though the hardness values were identical at 23°C. The former were free from cracks at the indentations, whereas stoichiometric oxides exhibited extensive cracking around and between indentations. The behavior of actual, thick (72 μm) oxide films during tensile deformation of oxidized metal samples indicated that considerable plasticity occurs in the oxide at 500°C but that the films are brittle at 23°C. It was concluded that the plasticity of the oxide may be greater than that of the oxygen-contaminated substrate at elevated temperatures and may be the means by which epitaxial strains are minimized. (auth)

25010 THE ANODIC BEHAVIOUR OF U, Ti, Zr, Nb, AND Ta IN 3 M $AlCl_3$-DIETHYL ETHER SOLUTION. A. J. Johnson and L. L. Shreir (London Univ.). Corrosion Sci., 5: 269-78(Apr. 1965).

The anodic behavior of U, Ti, Zr, Nb, and Ta was studied in non-aqueous 3 M $AlCl_3$-ether solutions using an Ag/AgCl-ether reference electrode to measure potentials. E-i curves for Ti and Zr are characterized by a plateau in which E increases rapidly at constant i and it is shown that these metals are electropolished in this region. Nb and Ta become etched when polarized in this solution and give E-i curves which resemble those of Pt. The mechanisms of electropolishing were considered and it is suggested that a film of metal chloride forms on the surface of Ti and Zr during electropolishing. (auth)

25011 THE MAGNETIC SUSCEPTIBILITY OF RADIUM CHLORIDE AND RADIUM BROMIDE. V. M. Vdovenko, Ya. V. Vasil'ev, and Yu. V. Dubasov. Dokl. Adad. Nauk SSSR, 159: 536-8(Nov. 21, 1964). (In Russian)

The molar susceptibilities of $RaCl_2$ and $RaBr_2$ were found to be equal to $-92 \pm 4 \times 10^{-6}$ and $-112 \pm 4 \times 10^{-6}$, respectively. The specific magnetic susceptibility of $RaCl_2$ depended slightly on the magnetic field and was extrapolated to H = ∞ in order to obtain an accurate value. The $RaCl_2$ sample contained a small amount of a ferromagnetic impurity. The experimental susceptibility of a weakly magnetic substance is equal to the sum of the diamagnetic and paramagnetic components: $\chi_{exp} = \chi_{dia} + \chi_{para}$. The value of χ_{dia} was estimated from the Kirkwood relation, and the values of χ_{para} were found to be 11×10^{-6} for $RaCl_2$ and 20×10^{-6} for $RaBr_2$. The ionic susceptibility of Ra^{2+} was calculated to be equal to -46×10^{-6}, which is in satisfactory agreement with a value of -43.7×10^{-6} obtained by using an ionic polarizability of $\alpha_{\infty}(Ra^{2+}) = 2.3$ Å^3 in the Kirkwood relation. (TTT)

25012 EVAPORATION OF TITANIUM IN Ti-Nb ALLOYS. A. A. Kuz'min and T. G. Moiseeva. Fiz. Metal. i Metalloved., 18: 925-9(Dec. 1964). (In Russian)

The vapor pressure of Ti was determined from the rate of evaporation of Ti from Ti–Nb alloys made in the form of a wire heated electrically in vacuum. The evaporation rate did not vary with time during the experiment. The vapor pressure data were correlated by an empirical equation of the following form: $\lg P_{atm} = A - B/T$. Values of the constants A and B are given over a temperature interval of 1600 to 1800°K for alloys containing 3.6 (7.549 and 24,752), 7.1 (7.577 and 24,939), 13.5 (7.800 and 25,396), 16.7 (7.840 and 25,510) 40.4 (7.897 and 25,906), 59.4 (8.029 and 26,595), and 80.1 wt % Nb (8.214 and 27,777). Values of A and B, respectively, are given in the parentheses. The activity coefficients of Ti in Nb–Ti alloys were calculated for 1600 and 1750°K, and were plotted as a function of the mol fraction of Ti. A negative deviation from Raoult's law was observed. (TTT)

25013 COMMENTS ON NOTE "METALLOGRAPHIC PREPARATION OF CeO_2." C. S. Yust and C. P. Haltom (Oak Ridge National Lab., Tenn.). J. Am. Ceram. Soc., 48: 216(Apr. 21, 1965). (ORNL-P-850)

The principal anomalies of porosity and a second phase of CeO_2 cited by Williams et al. (J. Am. Ceram. Soc., 47: [10] 538 (1964)) are discussed. The effects of incomplete polishing on these results are considered. The procedure used for preparation of cerium oxide microstructures is described, and conditions of the microstructure at three stages of polishing shown. (M.C.G.)

25014 NEW COMPOUNDS WITH PEROVSKITE-LIKE STRUCTURES. G. Blasse (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Inorg. Nucl. Chem., 27: 993-1003(May 1965).

A number of mixed metal oxides with perovskite-like structures are reported. On the sublattice of the smaller cations 1 : 1 and 1 : 2 long-range order were found in the perovskite as well as in the hexagonal barium titanate structure. The Jahn-Teller distortions of these compounds are discussed. Finally the energy terms stabilizing the hexagonal barium titanate structure relative to the perovskite structure are considered. It seems probable that anion polarization and not cation-cation bonding stabilizes the hexagonal barium titanate structure. (auth)

25015 CRYSTAL STRUCTURE OF ZIRCONIUM TETRAFLUORIDE. G. Brunton (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 1173-4(May 1965).

Previously reported x-ray powder pattern data for β-ZrF_4 are shown to be the same as that reported for monoclinic ZrF_4. Data are tabulated. (P.C.H.)

25016 YTTERBIUM–MAGNESIUM SYSTEM. O. D. McMasters and K. A. Gschneidner, Jr. (Ames Lab., Ames, Iowa). J. Less-Common Metals, 8: 289-98(May 1965). (IS-1048)

X-ray parametric, differential thermal, and metallographic methods were used to establish the ytterbium–magnesium phase diagram. A eutectic reaction occurs at 31.5 at. % Mg and 496°C. A eutectoid reaction associated with the 792°C α-β transformation temperature of pure ytterbium occurs at 8.0 at. % and 447°C. The maximum solid solubilities of Mg in α-Yb and β-Yb are 3.9 at. % and 8.3 at. %, respectively. On the magnesium-rich side a eutectic reaction occurs at 89.3 at. % Mg and 509°C, and at this temperature 1.2 at. % Yb dissolves in Mg. The intermetallic compound $YbMg_2$ was found to exist over a range of compositions and to melt congruently at 718°C. At 400°C the composition range for this hexagonal C14 ($MgZn_2$-type) Laves phase varies from 64.0 at. % Mg to 70.3 at. % Mg. The lattice parameters corresponding to these compositions are $a_0 = 6.2491$ Å, $c_0 = 10.127$ Å, and $a_0 = 6.2073$ Å, $c_0 = 10.056$ Å, respectively. The valence characteristics of ytterbium in these alloys are discussed. (auth)

25017 DISLOCATION STRUCTURES IN DEFORMED AND RECOVERED TANTALUM. Troy W. Barbee, Jr. and Robert A. Huggins (Stanford Univ., Calif.). J. Less-Common Metals, 8: 306-19(May 1965).

Dislocation structures in deformed tantalum were examined using transmission electron microscopy. It was found that the deformation structures formed in tantalum strained at temperatures between 25 and 1000°C are comparable to those found in iron on the basis of homologous deformation temperatures. Several observations pertaining to the distribution of tangles at low strains, the types of tangles formed, the mechanisms of tangle formation, and the formation of deformation cell structure from tangles are also reported. (auth)

25018 FIELD EMISSION FROM EPITAXIALLY GROWN YTTRIUM ON TUNGSTEN. Allan J. Melmed (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). J. Less-Common Metals, 8: 320-6(May 1965).

Direct observations were made of the epitaxial growth of Y crystals on W from the vapor phase in a field-electron emission microscope. Nucleation and growth occurs in small patches. Above 800°C the probability of growth of just one crystal on the field emitter surface is high. Nucleation occurs on or at the edges of {011} planes of W and the Y plane nucleated is {0001}, with a $\langle 11\bar{2}0 \rangle$ Y direction parallel to a $\langle 112 \rangle$ W direction. (auth)

25019 USE OF TAPERED SPECIMENS IN STUDIES ON GROWTH OF SINGLE CRYSTALS OF GADOLINIUM. I. M. Peterson, M. Smutz, and E. H. Olson (Ames Lab., Ames, Iowa). J. Less-Common Metals, 8: 352-3(May 1965). (IS-1068)

Tapered tensile specimens were made starting with vacuum-distilled Gd metal of 99.9% purity and single crystal growth by the strain-anneal technique was studied. It was found that the technique of using tapered specimens can be used in optimizing growth conditions for producing single crystals of Gd by this method. (P.C.H.)

25020 UTILIZATION OF BeO IN REACTORS. W. D. Manly (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 14: 3-18(1964).

Beryllium oxide possesses attractive nuclear and high-temperature properties, which justify its consideration and use in a number of reactor systems. Information on the basic and applied properties of BeO leading to its use in reactor systems is reviewed. BeO is being used, or planned for use, in the General Atomic Experimental Beryllium Oxide Reactor (EBOR), the Aerojet General Gas-Cooled Reactor (GCRE), the Atomics International SNAP reactors, and the Lawrence Radiation Laboratory Pluto ramjet reactor. These concepts are described briefly. Beryllium oxide is also under consideration for nuclear power plants for satellites and other space vehicles. Intrinsically, BeO is an excellent moderator and reflector material. Its physical and mechanical properties are in most cases sufficient to meet the basic material and engineering requirements for core components. Some of its more important attributes are: high thermal conductivity, good shock resistance, high refractoriness, compatibility with fuels, and inertness with gas coolants of interest up to 1600°C. In addition, the (n,2n) reaction possible with beryllium improves the neutron economy of the reactor system. There are, however, major problems associated with the use of BeO that influence its use. These problems are reviewed, with particular emphasis on considerations of reactor design and overall economics. (auth)

25021 THE OBSERVATION OF DISLOCATIONS IN BeO BY TRANSMISSION ELECTRON MICROSCOPY. R. S. Wilks (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 175-8(1964).

Defects in unirradiated beryllium oxide specimens were observed by transmission electron microscopy. They include dislocation lines, trails, and networks. (auth)

25022 RESIDUAL STRAIN AND THE 'FRACTURE STRESS-TEMPERATURE' RELATION IN BERYLLIUM OXIDE. T. W. Baker, P. J. Baldock, and F. J. P. Clarke (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 203-4(1964). (AERE-R-4437)

It is shown that the magnitude of residual strain due to anisotropic lattice expansion is sufficient to account for an experimental form of the fracture stress-temperature relation reported in the literature. (auth)

25023 SELF-DIFFUSION IN BERYLLIUM OXIDE. S. B. Austerman (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 14: 248-57(1964).

The diffusion coefficients of beryllium and oxygen ions in beryllium oxide of various types, including single crystal, were measured and compared with the kinetics of other diffusion-related processes. In general, the data indicated that the cation diffuses through the lattice via vacancies without significant grain boundary diffusion, while oxygen diffuses in polycrystalline BeO primarily through grain boundaries. (auth)

25024 ON ANOMALOUS GRAIN GROWTH OF ZIRCONIUM AND ZIRCALOY-2 IN THE HIGH-TEMPERATURE PHASE. H. G. Feller (Technische Universitat, Berlin). J. Nucl. Mater., 15: 238-40(1965). (In German)

The grain growth of Zr and Zircaloy-2 cones with various wall thicknesses was studied as a function of time. In 3 hr at 1000°C, the grains of the Zr sample reached a maximum size of 0.6 mm. If the samples were then heated again for 3 hr at 1000°C, abnormal grain growth was introduced after the second α-β transformation, and the linear relation between grain growth and wall thickness existed only for thin-walled samples. The occurrence of abnormal grain growth in Zircaloy-2 was unequivocal. The interpretation of these results is discussed. (J.S.R.)

25025 OBSERVATIONS ON THE STRUCTURE OF INTERMETALLIC COMPOUNDS OF THE BINARY SYSTEMS Pu–Ga and Pu–In. B. Hocheid, A. Tanon, and J. Despres (Commissariat a l'Energie Atomique, Montrouge, France). J. Nucl. Mater., 15: 241-4(1965). (In French)

Data on the composition, crystalline structure, stability, hardness, and regions of existence for intermetallic compounds in the Pu–Ga and Pu–In systems are tabulated and discussed. (J.S.R.)

25026 NEUTRON DIFFRACTION STUDY OF THE LONG-RANGE ORDER IN A SINGLE-CRYSTAL Cu_2NiZn. Makoto Hirabayashi (Tohoku Univ., Sendai), Sadao Hoshino, and Kikuji Sato. J. Phys. Soc. Japan, 20: 381-8(Mar. 1965).

It is shown by neutron diffraction that the alloy Cu_2NiZn forms the long range order after prolonged annealing at 300°C. The observed structure factors of the superlattice reflections with mixed indices are evaluated to be between 0.29 and 0.33×10^{-12} cm. Three structure models, whose unit cells are based upon the original face centered cubic cell containing four atoms, are proposed to interpret the experimental results. A good agreement between the observed and calculated structure factors is found in the following model, i.e., a nickel atom is at the origin, and a zinc and two copper atoms are statistically distributed at the three positions ($\frac{1}{2}$, $\frac{1}{2}$, 0, 0, $\frac{1}{2}$). Possibility of other two models is discussed on the basis of the present investigation as well as other physical properties. (auth)

25027 NON-VOLATILE FISSION PRODUCT DIFFUSION MEASUREMENTS IN URANIUM DIOXIDE. D. Naumann, W. Burk, and S. Riedel (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 98-101 (Feb. 1965). (In German)

A new method allowing the measurement of non-volatile fission product diffusion in ceramic fuels is described. The ceramic uranium powder, e.g., UO_2 suspended in liquid alkali chloride, is whirled up at a defined temperature, the liquid is separated by means of a metal frit, and replaced by fresh liquid. In the fractions let off the amount of fission products can be determined and plotted as a fraction of specific product total amount versus $\sqrt{t}$. (auth)

25028 BRITTLENESS OF REFRACTORY COMPOUNDS AND DUCTILITY OF METALS. S. C. Carniglia (Atomics International, Canoga Park, Calif.). Mater. Res. Std., 5: 244-6(May 1965).

The type of chemical bonding exhibited by a polycrystalline material is shown to determine its extensibility. Ductility requires homogeneous deformation on a microscopic level, to which the metallic bond is well suited. Refractory materials are brittle owing to their ionic or covalent bonds. These bonds are strongly directional, causing slip systems to be limited, grain boundaries to be imperfect, and impurities to be segregated at the grain boundaries; all of which inhibit grain-to-grain transfer of deformation. (auth)

25029 SPECIFIC APPLICATIONS OF NEUTRON DIFFRACTION TO THE STUDY OF METALS AND ALLOYS. M. Bernard Pinteau (Ecole des Mines, Paris). Metaux (Corrosion-Ind.), No. 471, 387-98(Nov. 1964). (In French)

The particular properties of neutron diffraction and the experimental techniques used are summarized. The principal applications are to studies of crystallographic problems, imperfections in crystalline structure, and magnetic phenomena. Examples of each of these are described and discussed. (J.S.R.)

25030 SOME INVESTIGATIONS OF THE NIOBIUM–TIN PHASE DIAGRAM. J. H. N. van Vucht, D. J. van Ooijen, and H. A. C. M. Bruning. Philips Res. Rept., 20: 136-61(Apr. 1965).

The constitution diagram Nb–Sn was studied with a variety of methods. Besides Nb_3Sn, two intermetallic compounds Nb_6Sn_5 and $NbSn_2$ are found. Chemical, crystallographic, and superconductive data are given for all the phases occurring in the system. Results are discussed and compared with those described in recent literature. (auth)

25031 CRITICAL CURRENTS OF SUPERCONDUCTING NIOBIUM–OXYGEN ALLOYS. D. J. van Ooijen and A. S. van der Goot. Philips Res. Rept., 20: 162-9(Apr. 1965).

Critical currents in a transverse magnetic field were determined on niobium wires containing known amounts of oxygen. Four different metallurgical states, obtained by various combinations of cold-work and heat treatment, were investigated. It was found that wires having domains of ordered oxygen showed the highest critical currents, in spite of a low dislocation density. Over the range investigated (0.20 to 1.30 at.%) the oxygen concentration was of no apparent influence on the critical currents in the mixed state. (auth)

25032 ELECTRICAL RESISTIVITY OF PURE METALS BELOW 1°K. I. Yoshida (Oxford Univ.). Phys. Letters, 16: 12-13(May 1, 1965).

The electric resistivity of some pure metals was measured from 1 to 0.4°K in search for an anomaly expected from the Wiedemann-Franz law. The results obtained on iron shows a slight variation of electric resistivity of about 3%, which is much less than that expected from the anomaly of the thermal conductivity. (L.B.S.)

25033 A NOTE ON THE SPECIFIC HEAT OF LIQUID SODIUM. H. Endo and S. Tamaki (Tohoku Univ., Sendai). Phys. Letters, 16: 41-2(May 1, 1965).

The specific heat of liquid sodium was calculated at 114 and 203°C using both the oscillating pair potential by Johnson et al., and the Dobbs-Jones type potential, and the radial distribution function taken from the data of Orton et al. The calculated values were found to be in satisfactory agreement with experimental values. (L.B.S.)

25034 THE V_2O_5–ThO_2 SYSTEM. Gilles Le Flem and Paul Hagenmuller (Laboratoire de Chimie Minerale de la Faculte des Sciences, Bordeaux). Rev. Hautes Temp. Refractaires, 1: 149-52(Apr.-June 1964). (In French)

Three new phases were brought to light in the V_2O_5–ThO_2 system: metavanadate $Th(VO_3)_4$, pyrovanadate ThV_2O_7, and orthovanadate $Th_3(VO_4)_4$. Their fields of existence and the crystalline parameters of orthovanadate, are reported. (auth)

25035 THE IONIZATION OF AIR IN A FURNACE AND THE MEASUREMENT OF THE RESISTIVITY OF MAGNESIA BETWEEN 1500° AND 1800°C. J.-P. Loup and A.-M. Anthony (C.N.R.S., Bellevue, France). Rev. Hautes Temp. Refractaires, 1: 193-9(July-Aug. 1964). (In French)

In air at atmospheric pressure and between 1,500 and 1,800°C the passage of a current can be observed between two insulated alumina tubes in a furnace. The linear variation of the current as a function of low voltages and the existence of a saturation current are characteristic of an ionized gas. This ionization of air is attributed to the emission of electrons by the thermionic effect of the walls of the furnace and their attachment to the molecules of oxygen in the air. This emission is the cause of leakage that follows an exponential relationship with the inverse of the

temperature and increases with the voltage. It is important to take account of this leakage in the measurement of the resistivity of oxides such as magnesia. Three methods for the determination of the true resistivity of magnesia are put forward: one is based on direct measurement of the resistance of a test-piece under high voltage (200 v) and the other two depend on the calculation of this resistivity from measurements made at a medium voltage (10 v). The effect of the geometry of the test-piece was also considered. (auth)

25036 DETERMINATION OF THE ATTENUATION FACTOR OF NEUTRON DIFFRACTION LINE INTENSITY FOR CYLINDRICAL SAMPLES. Z. Gheorghiu and D. Pasculescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 755-62(1964). (In French)

An experimental verification of the values of the attenuation factor for tubular samples, calculated analytically previously, was given. Four Pb–Cd alloys with different concentrations were used in order to vary the μR parameter, and the samples were formed of several coaxial tubes in order to vary the interior radius and, consequently, the r/R parameter (the exterior radius R being constant). The curves obtained for the measurements of the (111) ray of lead with a diffractometer were compared with the theoretical curves. (tr-auth)

25037 INVESTIGATION OF BINARY OXIDES OF TRANSITION METALS. L. M. Kovba and V. K. Trunov. Vestn. Mosk. Univ., Ser. II, Khim., No. 6, 32-3(Nov.-Dec. 1964). (In Russian)

The values of a, b, c, and z for three new compounds of the UO_2–MoO_3 series—UMo_2O_8, UMo_7O_{22}, and $UMo_{11}O_{35}$—are given. They are considered derivatives of α-UO_3-U_3O_8-U_2O_5 and are very close x radiographically. The oxides $UMeO_6$ (Me = W, Mo, Cr) are x radiographically similar and crystallize in the monoclinic system. The lattice parameters, which may be calculated from $UMoO_6$ data, are given together with those for $MoO_3 \cdot 4Nb_2O_5$, $MoO_3 \cdot 4Ta_2O_5$, and $WO_3 \cdot 4Nb_2O_5$. For the indexes of the powder x radiograms of the last two compounds, monocrystalline data for $MoO_3 \cdot 4Nb_2O_5$ were used. The structures of the compounds $MeO_3 \cdot 4M_2O_5$ may be considered derived from ReO_3. The indexes of most of the bright lines of $MeO_3 \cdot 4M_2O_5$ correspond to those of ReO_3, and the cell volumes are 23-fold greater. The z value for $Nb_2O_5 \cdot 3WO_3$ calculated from experimental ρ values was found to be 2.2 instead of 2, which was reported previously. Repeated studies of the system showed that the composition of this compound corresponds better to the formula $2Nb_2O_5 \cdot 7WO_3$. Conversion to $9Nb_2O_5 \cdot 16WO_3$ is accompanied by a 3-fold increase in the a axis. (TTT)

25038 THE STRUCTURE OF ZIRCONIUM TRISELENIDE $ZrSe_3$. W. Kroenert and K. Plieth (Technische Hochschule, Aachen and Technische Universität, Berlin). Z. Anorg. Allgem. Chem., 336: 207-18(Mar. 1965). (In German)

The unit cell of $ZrSe_3$ and the statistics of the reflections were determined by rotation and Weissenberg photographs. The monoclinic cell with the probable symmetry group $P2_1/m$ has the following lattice constants: a = 5.41, b = 3.77, c = 9.45 Å; $\beta = 97.5°$. The density is $Q_r = 5.70$ gcm^{-3}. There are 2 formula units of $ZrSe_3$ within the cell. The atomic parameters were determined by two-dimensional Patterson and Fourier syntheses. $ZrSe_3$ forms a layer lattice. Twins are easily created. The structure and possibility of building twins are discussed. (auth)

25039 NEW HIGH ALLOY ULTRA HIGH STRENGTH STEELS. J. C. Hamaker, Jr. and D. H. Yates (Vanadium–Alloys Steel Co., Latrobe, Penna.). Metals Park, Ohio, American Society for Metals, 1965, Technical Report No. W 10-2-65, 15p. (CONF-650215-3)

The rate of change in the strength of steels achieved during the past few decades is shown. Some of the higher strength steels are compared with their counterpart titanium and aluminum alloys on an equal weight basis using yield strength, notch strength, or fatigue strength as criteria. Vacuum melting and new alloy systems were particularly helpful in providing breakthroughs to higher strength levels while retaining sufficient ductility for structural applications. Applications in which strength properties above 300,000 psi, provided by the matrix steels by ausforming or by the new maraging alloys, might be used are summarized. (M.C.G.)

25040 COMMERCIAL USER REQUIREMENTS FOR NEW SPECIALTY STEELS. S. Yukawa (General Electric Co., Schenectady, N. Y.). 11p. Metals Park, Ohio, American Society for Metals, 1965, Technical Report No. W 10-7-65, 11p. $3.00. (CONF-650215-1)

From American Society of Metals, Western Metal Congress, Los Angeles.

Some examples of current and potential applications of specialty steels in products such as household appliances, electrical power generation and distribution equipments, and nuclear power reactors are described. The steels include special carbon and low alloy grades, ferritic and austenitic stainlesses, and heat resisting alloy steels. The features and characteristics pertinent to the selection and evaluation of the steels for these applications are noted. (auth)

25041 X-RAY STUDY OF SHORT-RANGE ORDER IN NICKEL ALLOYS CONTAINING 10.7 AND 20.0 ATOMIC PER CENT MOLYBDENUM. J. E. Spruiell and E. E. Stansbury (Univ. of Tennessee, Knoxville). 23p. (CONF-641118-1)

From Pittsburgh Diffraction Conference, Pittsburgh.

Studies were carried out, which established the feasibility of using x-ray methods to study the short-range order in quenched α solid solution of Ni_4Mo and the possibility of determining the mechanism by which the α-phase transforms to the long-range order β-phase. The results of an x-ray study of the short-range order in Ni solid solutions containing 20.0 to 20.7 at. % Mo are reported. An unusual distribution of diffuse scattering in reciprocal space was observed which, for the 20.0 at. % Mo alloy, changed in character when the quenched samples are aged below the critical temperature for long-range order. It was concluded that the short-range order in Ni_4Mo is greater after quenching from 900°C than from 1000°C. A model was developed for interpreting two-dimensional short-range order parameters. Data are presented in tables and graphs. (M.C.G.)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry.

Refer also to abstract 25724.

25042 (AAEC/E-133) EFFECT OF IRRADIATION ON THE MECHANICAL PROPERTIES OF BERYLLIUM METAL. G. T. Stevens and B. S. Hickman (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan. 1965. 16p. Dep.(mn).

Results are presented of mechanical property measurements on beryllium metal irradiated up to 6×10^{20} nvt > 1 Mev at 75–100°C and 3.2×10^{20} nvt at 550°C. The property changes are interpreted in terms of helium distribution in the material. (auth)

25043 (BNL-9160) RADIATION DAMAGE IN MYLAR EXPOSED TO MINIMUM IONIZING PROTONS. J. J. Hennessy and W. H. Moore (Brookhaven National Lab., Upton, N. Y.). Apr. 6, 1965. Contract AT-30-2-GEN-16. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effects of protons on the tensile strength and the stress/strain proportional limits of Mylar were investigated. Mylar foil stacks were rammed into the 1.0-Bev proton beam from the Cosmotron, for a total of 1.0×10^{16} circulating protons. The threshold for a decrease in the force required to break the foils was found to be $\sim 1.0 \times 10^{15}$ protons/cm^2; this force falls to half the unexposed value near 3×10^{15} protons/cm^2. Mylar has to be exposed to 2×10^{15} protons/cm^2 before the proportional limits depart from normal. An estimate of the radiation dose in the mylar was made. (D.L.C.)

25044 (CEND-2936-222) IRRADIATION TESTING OF CERAMIC FUELS. Interim Report, October 1, 1963 through November 30, 1964. G. Zuromsky, J. J. Koziol, and W. P. Chernock (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 1964. Contract AT(30-1)-2936. 173p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

Capsules containing fuel samples of 10 and 22 wt % UO_2 in CaO stabilized ZrO_2 and 10 and 25 wt % UO_2 in CeO_2 were radiation tested in the ETR and MTR to fission burnups of about 40% of the ^{235}U atoms. Fission gas release values ranged from 20% for the 10 wt % UO_2-ZrO_2 fuels to 75% for the 25 wt % UO_2-CeO_2 fuels, with intermediate values of 25% for the 10 wt % UO_2-CeO_2 fuels and 50% for the 22 wt % UO_2-ZrO_2 fuels. A good correlation was obtained between volume fraction of grain growth and fission gas release. This correlation was unexpected due to the different thermal histories of the fuel elements during irradiation. Void formation and agglomeration, fission gas agglomeration, and development of large radial grains were more predominant in the microstructure of the UO_2-ZrO_2 fuels than in the UO_2-CeO_2 fuels. It appears that grain growth begins at lower temperatures in the CeO_2-base samples. Both type fuels exhibited a multiphase area at the edge of the grain growth region, which may be due to fission product migration. Formation of metallic particles was observed in all fuels. It is postulated that these particles are either U–Zr–fissium or U–Ce–fissium alloys. There was no metallographic indication of transformation of the original single-phase face-centered cubic solid solutions. Long-time out-of-pile phase stability studies indicated retention of the single-phase face-centered cubic crystal structure after 250 to 300 days at temperatures of 1400 to 1475°C and 1380 to 1425°C for the zirconia- and ceria-base compositions. The metallic particles observed in the irradiated fuels were not detected. The thermal conductivities of the zirconia-base fuel compositions were measured for temperatures up to 2200°C. Data indicated a gradual decrease in conductivity at temperatures up to 1500°C followed by an increase in conductivity at temperatures above 1500°C. Unclad pellets of the four fuel compositions showed corrosion penetrations of less than 0.001 in. following 700 days exposure to 650°C flowing steam and 480 days in 360°C degassed water. (W.L.G.)

25045 (GA-5314) IRRADIATION TEST OF THE GAIL III-B FUEL ELEMENT IN THE GENERAL ATOMIC IN-PILE LOOP. R. F. Turner, R. G. Baumgartel, H. I. Leon, E. O. Winkler, and L. R. Zumwalt (General Atomic, San Diego, Calif.). July 10, 1964. Contracts AT(04-3)-314 and AT(04-3)-167. 69p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The General Atomic In-Pile Loop (GAIL) was used for the extended testing of coated-particle-graphite-matrix fuels at high burnup. The GAIL III-B fuel element operated at full power for more than 10,000 hr and generated 685.5 Mw-hr of energy. The fuel element consisted of a graphite matrix containing pyrolytic-carbon coated $(Th,U)C_2$ particles. The test confirmed the exceptionally long life of which this type of fuel is capable, provided fission product release data as a function of burnup, proved that the levels of radioactive and chemical impurities can be maintained at very low levels in the helium coolant, proved the ease of access to loop and trapping-system components following shutdown, and proved the effectiveness of a moderately impermeable graphite sleeve as a barrier to fission product release. (C.E.S.)

25046 (HW-83615) PROGRESS ON THE IRRADIATION DAMAGE TO REACTOR METALS PROGRAM. A SUMMARY OF HANFORD LABORATORIES ACHIEVEMENTS IN THIS PROGRAM UNDER GENERAL ELECTRIC COMPANY MANAGEMENT, 1962–1964. J. C. Tobin (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 15, 1964. Contract AT(45-1)-1350. 56p. Dep.; $3.00(CFSTI); 2(mn) CFSTI.

A summary of the progress in the areas of alloy selection, in-reactor measurements, irradiation effects, environmental effects, damage mechanism studies, and very-high-temperature radiation effects is given. (W.L.G.)

25047 (NAA-SR-Memo-10509) RADIOCHEMICAL TECHNIQUES IN FISSION GAS MOBILITY STUDIES OF HYDRIDE SYSTEMS. A. J. Moses (Atomics International, Canoga Park, Calif.). Sept. 29, 1964. Contract AT-11-1-GEN-8. 12p. (CONF-721-14). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

Radiochemical aspects of fission gas mobility studies of hydride systems are described and typical test data offered for fission gases, recoil into ZrH_x foils. (auth)

25048 (NP-14889) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Process Report No. 16, October 1964–December 1964. (Lockheed-Georgia Co., Marietta). Contract NASw-114. 56p. (ER-7702)

In-pile and out-of-pile screening tests with post-irradiation metallographic analyses on stainless steels and aluminum alloys were continued. In-pile results from aluminum 1099 alloys indicate that the radiation induced defects diffuse to grain boundaries rather than to dislocations or coalesce and thereby impede dislocation motion. The screening program was terminated due to the build-up of ^{187}W activity in the primary coolant system, and a compilation of the test results was initiated. Preliminary x-ray and electron micrograph studies were also started. (W.L.G.)

25049 (NP-15022(Vol.II)) SNAP-8 RADIATION EFFECTS TEST PROGRAM. VOLUME II. ELECTRICAL INSULATION MATERIALS. (Lockheed-Georgia Co., Marietta). Nov. 1964. For Aerojet General Corp., Azusa, Calif. Subcontract OP367736. 158p. (ER-7591)

Irradiations were carried out on sheet insulation, wire, fluids, and statorettes. The results obtained are discussed individually. (D.L.C.)

25050 (NUMEC-3432-7) DATA PACKAGE FOR NUMEC'S IRRADIATION TESTING PROGRAM. CAPSULES NU-17, NU-18, AND NU-19. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Feb. 8, 1965. Contract AT(30-1)-3432. 101p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The data required for the long-term irradiation of UO_2-PuO_2 in capsules NU-17, NU-18, and NU-19 are presented. They include: equipment, flux requirements, heat production, temperatures, fission gas pressure, heat transfer calculations, fabrication, hazards, alarms, etc. (D.L.C.)

25051 (ORNL-3731(p.111-51)) INVESTIGATIONS OF FISSION-PRODUCT BEHAVIOR. O. Sisman, H. W. Savage, and G. M. Watson (Oak Ridge National Lab., Tenn.).

Results of radiation effects testing of fine-grained UO_2 single crystals confirmed the prediction that grain boundaries would reduce fission gas release. Results of irradiation testing indicate that C coatings will operate at 2500°F to 20 at. % burnup in gas cooled reactors. Fission-gas release from high-burnup coated particles was measured, and studies of actinide migration in pyrolytic carbon were continued. Data on fission product transport and deposition and on fission product sorption by stainless steel are reported. (J.R.D.)

25052 (ORNL-3731(p.154-206)) INVESTIGATIONS OF MODERATOR MATERIALS. W. O. Harms, H. C. McCurdy, H. W. Savage, G. M. Watson, and F. J. Witt (Oak Ridge National Lab., Tenn.).

In-pile creep experiments were completed on specimens of AGOT, CGB, and isotropic grades of graphite. Experiments were also completed on graphite oxidation in CO_2 and steam. A study of EGCR-type graphite failure in radiation fields is discussed. (J.R.D.)

25053 (RNL-3731(p.207-28)) STUDIES OF ADVANCED SYSTEMS. (Oak Ridge National Lab., Tenn.).

Calculations were made of the reactivity lifetimes and the associated conversion ratios and fuel-cycle costs for fully enriched U with Th, Pu with Th, and partially enriched U. Both recycle and nonrecycle fuel management were con-

sidered. Conversion ratios higher than 0.9 were obtained for the recycle systems using Th as fertile material either with fully enriched U or Pu as makeup. There were no cases in which a conversion ratio of unity was obtained together with a burnup high enough to be economically attractive. The lowest fuel-cycle cost was for the Pu–Th non-recycled fuel, which gave 0.57 mills/kwhr(e) based on Pu fuel available at $7/g of fissile material. An IBM 7090 code is being written for the calculation of various types of transients in a fast reactor. The behavior of ceramic oxides and refractory-metal carbides toward high fast-neutron doses at high temperatures is being investigated. The irradiation experiments are designed to separate the parameters of fast-neutron dose, flux, and temperature, as well as the fabricational parameters. A series of BeO experiments is nearly complete, a similar study of MgO and Al_2O_3 is in progress, and a series of irradiations of refractory metal carbides and high purity Al_2O_3 and Y_2O_3 was initiated. (J.R.D.)

25054 (ORNL-3731(p.272-89)) IRRADIATION TESTING OF COMPONENTS AND MATERIALS. H. C. McCurdy, O. Sisman, and M. S. Wechsler (Oak Ridge National Lab., Tenn.).

The last three of 17 EGCR prototype capsules were removed from the ETR. Of the 13 capsules examined thus far, four were ruptured. Two prototype UO_2-fueled capsules are being irradiated. The results of neutron flux measurements at each of several positions for each capsule are presented. The second element that was designed to be vented was examined after irradiation. As suspected because of the small amount of fission gas in the coolant, there was no vent. Three ETR-irradiated prototype capsules were examined nondestructively, and the destructive examination of a fourth was completed. Capsules E-1R, E-4R, and E-10 had no cladding fractures and only nominal cladding distortions. The gamma scans showed no unusual features. Metallographic examination of capsule E-7, which had two large cladding fractures, showed that the causes of failure were nitride embrittlement of the cladding and overheating of the fuel, which caused the embrittled cladding to fracture. The schedule of surveillance sample exposure in the EGCR was revised to include tensile specimens of a reference heat of ASTM A-212 grade B steel and synthetic heat-affected-zone specimens from two heats of steel used in the EGCR pressure vessel. A series of elevated-temperature irradiations of samples of EGCR steels is under way. (auth)

25055 (TRG-Report-511) APPLICATION OF THE EQUIVALENT DOSE AND TEMPERATURE CONCEPTS TO IRRADIATION-INDUCED CHANGES IN THE MECHANICAL PROPERTIES OF STEEL. H. Bridge and B. T. Kelly (Reactor Group, United Kingdom Atomic Energy Authority, Culcheth (England)). Mar. 6, 1963, Reprinted 1965. 20p. (NPCC-MWP(S)/P(63)19). Dep.; $0.70(BIS), 3s. 6d. (HMSO).

The concepts of equivalent dose and equivalent temperature, already used successfully to correlate irradiation damage rates in graphite from different irradiation facilities, are described. The method of application of these concepts to irradiation-induced property changes in iron and steel is discussed, and the Kinchin and Pease damage model together with calculated neutron spectra are used to illustrate the system of equivalent dose estimation. It is concluded that the data available are not adequate to provide an acceptable value of the activation energy to be used in the equivalent temperature correction; order of magnitude calculations of this effect are performed. A discussion is given of possible reasons for the failure of these concepts when applied to the yield point and ductile-brittle transition temperature of steels, and it is concluded that it is essential to test these concepts experimentally. It is suggested that the system be adopted as an interim measure. (auth)

25056 (TRG-Report-862) HIGH-PRECISION DENSITY MEASUREMENTS ON IRRADIATED URANIUM CARBIDES. B. G. Childs and K. Buxton (Reactor Group, United Kingdom Atomic Energy Authority, Dounreay (Scotland)). Oct. 2, 1964. 30p. Dep.; $0.90(BIS), 4s. 6d. (HMSO).

Techniques are described by which the density of irradiated uranium carbide specimens, 0.15 cm^3 in volume, can be measured to an accuracy of about 2 parts in 10^4. The variation in density with neutron exposure, observed for a number of specimens irradiated at 50°C, was found to agree in general with that calculated from the corresponding changes in lattice parameter for similar specimens. Negligible internal cracking or microscopic pore or bubble formation thus occurred in the specimens. Subsequent density changes, which occurred when the specimens were annealed, were found to depend critically on variables such as specimen composition and neutron exposure. This suggests that the annealing behavior of irradiated uranium carbide is more complex than has hitherto been supposed. (auth)

25057 THERMALLY ACTIVATED SLIP IN NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. R. J. Arsenault (Oak Ridge National Lab., Tenn.) and T. J. Koppenaal. Appl. Phys. Letters, 6: 159-60(Apr. 15, 1965).

The temperature dependence of the activation energy and activation volume for slip in neutron-irradiated copper single crystals was investigated experimentally by creep testing. Both were found to be temperature-independent. (D.C.W.)

25058 RESISTIVITY OF PURE IRON AND DOPED IRON, BOMBARDED WITH ELECTRONS AT 20°K. Colette Minier-Cassayre (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 260: 2163-6(Feb. 22, 1965). (In French)

A comparative study of iron bombarded at low temperature by electrons and neutrons permitted a test of the interpretation of the anneal of the faults created. The effects of the addition of impurities were also studied (tr-auth)

25059 THE IRRADIATION GROWTH OF URANIUM AT 77°K. Nobuyuki Sasao, Claude Weinberg, and Yves Quere (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Compt. Rend., 260: 2763-5(Mar. 8, 1965). (In French)

The growth of uranium by neutron irradiation at 77°K was measured at the temperature of irradiation. The true growth coefficients are given. A part of this growth disappeared by annealing at room temperature. The preponderant role of the density in crystalline faults is emphasized. (tr-auth)

25060 INORGANIC RADICALS TRAPPED IN GLASSES AT ROOM TEMPERATURE. II. Cd^+ AND Ni^+ IN METAPHOSPHATE GLASS. T. Feldmann, A. Treinin, and V. Volterra (Hebrew Univ., Jerusalem). J. Chem. Phys., 42: 3366-70(May 15, 1965).

The effects of uv and x radiations on sodium metaphosphate glass doped with either $CdSO_4$ or NiO, were studied. The optical and ESR absorptions of the glass were measured. The formation of Cd^+ and Ni^+ was demonstrated. A new interpretation is given to the color centers induced by irradiation in the pure base glass. (auth)

25061 RADIATION EFFECTS IN BeO. C. G. Collins (General Electric Co., Cincinnati). J. Nucl. Mater., 14: 69-86(1964).

Expansion, microstructure, and property observations on irradiated BeO specimens of several grain sizes and densities are reported following neutron irradiation at dosages up to 1.5×10^{21} nvt ($\geq$1 Mev) at temperatures from 100 to 1200°C. The total expansion at 100°C was greater than 6% at dosages of $\sim 7 \times 10^{20}$ nvt and ranged from 5% at 600°C to about 1% at 900 to 1000°C at the maximum dosage. The expansion was of two basic types: one in which the specimens remained intact and the strength was essentially unchanged, and a second in which the specimens cracked at the grain boundaries and a marked decrease in the strength occurred. Microcracking was dependent on the volume expansion and occurred in specimens of 10 to 20 μ grain size at volume increases ranging from 0.5% at 100°C to approximately 1% at 1000°C. Factors in the expansion other than microcracking in-

cluded lattice expansion, clusters of defects, and helium bubbles, which formed at the grain boundaries. Above ~600°C, a vacancy excess resulted in expansion several times that indicated by the changes in lattice parameters. Helium bubbles were estimated to account for approximately 20% of the observed expansion in some cases at 10^{21} nvt. Expansion at temperatures above 600 to 650°C was found to follow first order kinetics in which the rate-controlling process appeared to be vacancy migration. Equations describing the expansion are utilized together with the volume dependence of the microcracking to define the irradiation conditions under which beryllium oxide can be used in practical applications. (auth)

25062 IRRADIATION EFFECTS ON BERYLLIUM OXIDE MATERIALS. R. G. Mills, J. O. Barner, D. E. Johnson, and M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Mater., 14: 125-34(1964).

The results of irradiation experiments on 134 beryllium oxide specimens are presented. The variables that were studied include the effects of the density, grain size, composition, shape, and temperature of irradiation of the specimens. The peak exposure in the irradiation capsule was 1.0×10^{21} nvt (>1 Mev) fast neutron flux. The temperatures of the specimens ranged from about 340 to 720°C. Excellent resistance to cracking was exhibited by the high-density, fine-grain-size specimens. The highest strength and strength retention after irradiation was exhibited by the high-density, small-grain-size, 1% MgO-containing specimens irradiated in the high neutron flux-high temperature section of the capsule. Thermal expansion measurements provide a unique means of establishing the annealing behavior of the defects produced by irradiation. In irradiated beryllium oxide, a contraction began at 850°C. Growth of BeO specimens as high as 1.4% was noted. Strengths of irradiated pieces decreased from 14 to 70% of the pre-irradiated values. (auth)

25063 IRRADIATION-INDUCED GROWTH IN OXIDES OF BERYLLIUM, MAGNESIUM AND ALUMINIUM. J. A. Desport and J. A. G. Smith (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 135-40(1964). (AERE-R-4443)

Results are presented from the early part of an investigation of the radiation stability of beryllia, magnesia, and alumina. The principal effect studied was growth, and some measurements were made of the effect on elastic properties. The extent to which radiation damage, as revealed by these effects, may be eliminated by heat treatment was also investigated. (auth)

25064 ELECTRON MICROSCOPY OF IRRADIATED BeO. R. S. Wilks and F. J. P. Clarke (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 179-86(1964). (AERE-R-4435)

Irradiation damage may be produced in BeO by exposure of unirradiated BeO in the electron microscope and by reactor irradiation. At doses $\gtrsim 10^{20}$ nvt the damage is in the form of defect agglomerates; these agglomerates and the effects annealing on them are described and discussed. (auth)

25065 MECHANISMS OF IRRADIATION-INDUCED GROWTH AND CRACKING IN BERYLLIA. F. J. P. Clarke, R. S. Wilks, and D. H. Bowen (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 14: 205-7(1964).

Anisotropic expansion of the BeO lattice leads to the storing of strain energy in a polycrystalline material because of grain boundary constraint. At low irradiation temperatures and doses below about 5×10^{20} nvt at least, this strain energy can be estimated from x-ray lattice expansion data. At elevated temperatures or higher doses however, crystal growth due to radioinduced defects, which do not affect the lattice parameters, e.g., dislocation loops, may contribute appreciably to the strain energy. Work on determining the role of radioinduced defects is summarized. (auth)

25066 IRRADIATION EFFECTS ON DISPERSION TYPE BeO–UO_2 FUELS FOR EBOR. R. G. Mills, J. O. Barner, D. E. Johnson, and M. T. Simnad (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Mater., 14: 482-6(1964).

Fuel pellets composed of 70 vol % BeO–30 vol % UO_2 were irradiated to a burnup of 55% of the ^{235}U atoms (corresponding to 3.7×10^{20} fissions/cm^3). The peak fuel temperature was 1100°C. The experiment was designed to study the effect of UO_2 particle size on the performance of fuel pellets at temperatures, heat flux conditions, and burnups of interest to the Experimental Beryllium Oxide Reactor program. The coarse particle pellets showed little change in dimension and remained intact. The fine particle pellets fractured into several pieces. The release of fission gases from the fine particle pellets was less than 0.1%. No fission gas release data were obtained for the coarse particle pellets. (auth)

25067 CURVILINEAR LAYERS OF X-RAY SCATTERING DUE TO IRRADIATION BY NEUTRONS OF MONOCRYSTALLINE BeO. B. Belbeoch, J. Rodot, and M. Roulliay (CEN, Saclay, France). J. Nucl. Mater., 15: 234-7(1965). (In French)

The diffraction diagrams for BeO after irradiation can be classified into three types as a function of c/a. The results of studies on type 2, characterized by the profile of the rays $(\underline{h}, \underline{k}, 2\underline{n})$, are presented. All the $(\underline{h}, \underline{k}, \underline{l})$ $\underline{l} \neq 0$ rays and the rays with $\underline{l} = 2\underline{n}$ in particular, had a dissymmetry toward large angles. Trails in the forms of crosses were observed around the nodes $(\underline{k}, \underline{k}, \underline{0})$ and $(\underline{h}, \underline{k}, 2\underline{n})$ with $\underline{h} - \underline{k} = 3\underline{n}$. The node rows parallel to $\underline{c}$ with $\underline{h} - \underline{k} \neq 3\underline{n}$ were connected by diffusion trails that were not rectilinear. Possible interpretations of the results are discussed. (J.S.R.)

25068 EFFECTS OF HIGH BURNUP ON BULK UO_2 FUEL ELEMENTS. T. D. Anderson. Nucl. Safety, 6: No. 2, 164-9(Winter 1964-65).

Irradiation results from groups of bulk UO_2 fuel specimens in which some of the specimens received burnups of at least 25000 Mwd per metric ton of oxide are reviewed. Data from irradiations of plate fuel elements for PWR core 2 are presented. Two rates of UO_2 swelling were observed. During the initial irradiation period the apparent rate of fuel volume increase was 0.045% per 1000 Mwd/metric ton. After a critical burnup the rate increased to 0.2% per 1000 Mwd/metric ton. Fission gas release also increased with burnup. Results of irradiations of rod fuel elements for PWR core 1 are also presented. The values of burnup to failure were entirely consistent with a fuel volume increase of 0.2% per 1000 Mwd/metric ton, as was observed for the UO_2 plate specimens. High-burnup irradiations were performed on PuO_2–UO_2 fuel rods. The fission gas release was quite high and no excessive swelling was observed. (M.C.G.)

25069 ON THE SUB-STRUCTURE OF STAGE I_D-3 IN NEUTRON IRRADIATED Al. S. Ceresara (Istituto Sperimentale Metalli Leggeri, Novara, Italy), H. Elkholy, T. Federighi, and F. Pieragostini. Phys. Letters, 16: 8-11(May 1, 1965).

Samples of well-annealed zone refined Al were irradiated at −196°C in the avogadro RS 1 reactor at a fast neutron dose of 719×10^{16} n/cm^2, and differential isochronal curves for the recovery stage I_D-3(−110 to 0°C) are shown in comparison with previous experimental results. The activation energy was determined to be 0.61 ± 0.03 ev by the method of slope change when changing the annealing temperature. It is concluded that a single process seems to occur in the whole stage and that this process should correspond to the annealing of mobile vacancies to the immoble interstitial aggregates formed during irradiation. (L.B.S.)

25070 RECOVERY AND PRODUCTION RATES OF ELECTRICAL RESISTIVITY INDUCED BY 1.25-3.25 Mev ELECTRONS IN PURE COPPER, NICKEL AND IRON. John Aloysius Tesk. Thesis, Evanston, Ill., Northwestern Univ., 1964. 77p.

Three new substages (I_2, I_7, I_9) were detected in the Stage I recovery of Cu following electron irradiation in the range 1.48 to 3.25 Mev, and a fourth (I_6) was indicated by the data.

Substage I_2 occurs at 22-23°K and represents 1.5-2% recovery. I_7 occurs around 45°K and tends to merge with I_5 at higher concentrations. Substage I_9 occurs between 53 and 59°K, represents ~1% recovery, and appears to shift from 59 to 53°K with increasing defect concentration. The slight bowing out of peak I_5 between I_5 and I_7 indicates that another substage, I_6, could be present. A comparison of the new recovery spectrum of Cu with that of Au indicates that the first few substages of recovery are due to the same processes. Stage I recovery in Ni is very similar to that of Cu, indicating that Stage I recovery in both Ni and Cu is due to the same types of defects and interactions. Apparently there is more substructure in the Stage I recovery of Fe than in Ni and Cu. Rates of defect production in all three metals show substantial, rather sharp increases between 1.48 and 1.65 Mev. The increases for Cu, Ni, and Fe amount to 100, 150, and 40% respectively. A comparable effect on the recovery spectra was not observed. (A.G.W.)

PHYSICS

General

25071 (TID-21667) QUARTERLY PROGRESS REPORT NO. 76. H. J. Zimmermann and G. G. Harvey (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Jan. 15, 1965. Contract AT(30-1)-1842. 370p. Dep.(mn); $7.00(cy), 6(mn) CFSTI.

Research progress is reported on molecular beams, microwave spectroscopy, radio astronomy, optical and infrared spectroscopy, ultrasonic properties of solids, geophysics, noise in electronics, magnetic resonance, soft x-ray spectroscopy, enzymatic reactions, acoustics, electrodynamics equations, plasma physics, plasma electronics, magnetohydrodynamics and energy conversion, statistical communication theory, process analysis and synthesis, processing and transmission of information, artificial intelligence, speech communication, mechanical translation, linguistics, cognitive information processing, communications biophysics, neurophysiology, neurology, cardiovascular system mechanisms, computer research, computation systems, and stroboscopic mechanisms. (J.R.D.)

25072 (LA-tr-65-7) TRANSFER PHENOMENA IN COMPRESSED GASES. II. EMPIRICAL EQUATION FOR THE RELATION BETWEEN THE HEAT CONDUCTIVITY OF COMPRESSED GASES AND TEMPERATURE AND PRESSURE. E. A. Stoliarov. Translated for Los Alamos Scientific Lab., N. Mex., from Zh. Fiz. Khim., 24: 279-91 (1950). 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $2.60(fs), $0.89(mf) JCL.

On the basis of a consideration of the heat conductivity of gases under pressure in the reduced form, an empirical equation is found that relates the effect of pressure and temperature on the heat conductivity of gases. The effect of P on the λ of gases is considered. It is shown that the derived equation permits calculations to be made on the heat conductivities of gases. It is shown that near the critical temperature in gases there arises some mechanism of heat conductivity that also causes the appearance under these conditions of a negative temperature coefficient of heat conductivity. The dependence of the constant F in the equation $\lambda = F\eta\, C_v$ on pressure is shown. Values of the Prandtl number are calculated, which confirm the emergence of a liquid mechanism of heat transfer in gases near the critical temperature. (auth)

25073 VARIANTS OF CANONICAL FORMALISM. Elihu Lubkin (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 32: 218-58(Apr. 1965). (UCRL-11637)

Canonical formalism is presented in invariant notation as one of a family of solutions of the problem of finding infinite-dimensional subgroups of the group of all time-independent flows of points in a real n-dimensional space. When the problem is restricted to a local study with the flows restricted to such as are specified by a flow vector field with analytic components, and a geometry in the first-order neighborhood of each point specified by a real irreducible Lie group of n by n matrices is required to be preserved by the motions, then a limited number of classes of solutions appear (theorems of Ruh and Matsushima). Ordinary canonical formalism is produced from one of these classes by an extra assumption of flatness. It is shown that, if the flatness assumption is replaced by one of maximum twist, no motions at all are possible. (auth)

25074 DIFFERENT BANDS FOR DIFFERENT SPINS. III. SOLID ATOMIC HYDROGEN. Jean-Louis Calais (Uppsala Univ.). Arkiv Fysik, 29: 255-73(1965).

The AMO method is applied to a bcc crystal of hydrogen atoms. All the many-center integrals are taken into account, and the errors involved in these computations are estimated. To get meaningful results, quite high precision is needed. The results show a minimum in the potential energy curve, which is a little lower than the one obtained by Wigner and Huntington. The minimum occurs at an internuclear distance which is somewhat larger than the one obtained by Wigner and Huntington. A survey is given of some previous work both on solid atomic and solid molecular hydrogen. The possible implications of such calculations for planetary physics are also pointed out. (auth)

25075 BEAM PROFILE AND THE POTENTIAL DEPRESSION OF STRIP ELECTRON BEAMS. G. J. Butterworth (London Univ.). Intern. J. Electron. (1), 18: 235-41 (Mar. 1965).

Profiles of an electron beam with rectangular cross section and high space-charge density were measured using two probe techniques. The potential depression at the waist of an initially convergent strip beam was evaluated analytically, and the result was checked by probing the depression with a second electron beam. (auth)

25076 ENERGY EXCHANGE BETWEEN AN ELECTRON BEAM AND A GAP IN THE PRESENCE OF COLLISIONS. C. N. Lashmore-Davies (Standard Telecommunication Labs., Harlow, Essex, Eng.). Intern. J. Electron. (1), 18: 243-53(Mar. 1965).

The energy exchange between an electron beam and a gap in the presence of collisions is treated by means of a one-dimensional theory. The aim of the calculation is to discover the effect of collisions on the negative conductance known to occur for a certain range of gap lengths in the absence of collisions. A collision term is introduced phenomenologically into the equation of motion for the electrons, and the small signal power theorem is also modified to take account of collisions. It is found that the effect of collisions is surprisingly small, a negative gap conductance still being obtained for collision frequencies as high as the plasma frequency. (auth)

25077 ON MACROSCOPIC ROTATIONS DUE TO INTERACTION WITH POLARIZED PARTICLES. E. G. Beltrametti (Universita, Genoa and INFN, Genoa). Nuovo Cimento (10), 37: 346-8(May 1, 1965).

Macroscopic rotations of a (free and isolated) body arising in interactions with polarized particles, typically with electrons, are discussed. The source of the rotational energy $E = M^2/2I$, where M is the angular momentum and I is the moment of inertia, is considered. It is pointed out that the energy of the incident particles plays the essential role. (C.E.S.)

25078 ON FLUCTUATIONS IN STATISTICAL MECHANICS. [PART] II. R. C. T. da Costa (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo Cimento (10), 37: 463-73(May 16, 1965).

General expressions for small fluctuations are obtained for the case of macroscopic quantities Q relative to a system composed by s weakly interacting gases, when one knows the values taken by certain macroscopic constants of motion K. Both Q and K are assumed to have the form $\Sigma_{j=1}^{s} \int \varphi_{ij}(x,p)\, q_i(x,p)\, dx\, dp$, where φ_{ij} is an arbitrary function of the co-ordinates and momentum and q_i is the particle density of the j-th gas in the system. A geometrical interpretation for the results obtained is also discussed. (auth)

25079 ON TRANSPORT THEORY IN REAL GASES. S. Grossmann (Universitat, Marburg, Ger.). Nuovo Cimento (10), 37: 698-713(May 16, 1965).

Transport phenomena in moderately dense gases are studied up to the second virial coefficient with the Boltzmann-Landau equation for quantum gases at temperatures above T_c. Modified Eulerian equations for quasi-equilibrium processes are given. Equilibrium thermodynamics including interaction are found from transport theory.

First sound velocity in a real gas is derived. The possibility of zero sound in a real, moderately dense gas at high temperatures is shown. A zero sound dispersion relation is given. (auth)

25080 MASTER EQUATIONS AND MARKOV PROCESSES. Irwin Oppenheim (Massachusetts Inst. of Tech., Cambridge) and Kurt E. Shuler. Phys. Rev., 138: B1007-12(May 24, 1965).

The processes described by generalized master equations (GME), derived from the Liouville equation on the basis of various physical and dynamic arguments, were termed Markovian or non-Markovian depending upon whether the GME did not or did involve an explicit time integration. It is shown that these designations are not in accord with the (very specific) mathematical definitions of Markovian and non-Markovian processes. It is demonstrated that the GME does not contain sufficient information to determine whether or not the stochastic process described by it is Markovian or non-Markovian. (auth)

25081 COHERENCE PROPERTIES OF OPTICAL FIELDS. L. Mandel and E. Wolf (Univ. of Rochester, N. Y.). Rev. Mod. Phys., 37: 231-87(Apr. 1965).

A review of coherence properties of electromagnetic fields and their measurements, with special emphasis on the optical region of the spectrum, is presented. Analyses based on both the classical and quantum theories are described. After a brief historical introduction, the elementary concepts which are frequently employed in the discussion of interference phenomena are summarized. The measure of second-order coherence is then introduced in connection with the analysis of a simple interference experiment and some of the more important second-order coherence effects are studied. Their uses in stellar interferometry and interference spectroscopy are described. Analysis of partial polarization from the standpoint of correlation theory is also outlined. The general statistical description of the field is discussed in some detail. The recently discovered universal "diagonal" representation of the density operator for free fields is also considered and it is shown how, with the help of the associated generalized phase-space distribution function, the quantum-mechanical correlation functions may be expressed in the same form as the classical ones. The statistical properties of thermal and nonthermal light and the temporal and spatial coherence of black-body radiation are considered. Fourth- and higher-order coherence effects and the photoelectric detection process are also discussed. Among the fourth-order effects described in detail are bunching phenomena, the Hanbury Brown–Twiss effect and its application to astronomy. A discussion of various transient superposition effects, such as light beats and interference fringes produced by independent light beams, is given. (auth)

25082 THERMAL DIFFUSION IN BINARY GAS MIXTURES AND INTERMOLECULAR FORCES. S. C. Saxena and B. P. Mathur (Rajasthan Univ., Jaipur, India). Rev. Mod. Phys., 37: 316-25(Apr. 1965).

The available binary thermal diffusion data for a number of gas systems as a function of temperature and composition were critically examined and interpreted using the kinetic theory of Chapman and Enskog. In the computation of the thermal diffusion factor α_T two familiar central intermolecular potentials, viz., Lennard-Jones and modified Buckingham exp-six were considered. The theoretical expressions for α_T employed are of known and tolerable accuracy so that the uncertainty associated on this account in many early interpretations is avoided. The scope of work is confined mostly to inert gas mixtures as the kinetic theory is rigorously developed so far only for such systems. This comprehensive effort brings to light many interesting points. A general deficiency is realized in the available α_T data. Even for some systems where data exist as a function of composition, it is found that the composition range which is theoretically interesting is not investigated. This study also leads to the unpleasant prospect that some of the available data may be in error. Thus, many indications are provided for planning future work on α_T measurements. Further, the L–J potential is found to be inadequate for representing the force field of these molecules and especially for such systems where He is one of the two components. To be specific, the choice of a repulsive index as twelve is found to be a bit large. The exp-six potential has succeeded in general to explain the α_T data of many of the systems discussed. (auth)

25083 ORIENTED NUCLEI. POLARIZED TARGETS AND BEAMS. J. M. Daniels. Pure and Applied Physics. A Series of Monographs and Textbooks. New York and London, Academic Press, 1965. 287p.

A survey on the experimental and theoretical aspects of the production of polarized nuclei and particles is presented, with emphasis on the experimental aspects. Thermal and nonthermal equilibrium methods of orienting nuclei are described, together with experimental techniques and equipment for nuclear orientation. The production of polarized particles by nuclear reactions, polarized ion sources for accelerators, and experiments with oriented nuclei are also covered. 550 references. (D.C.W.)

25084 SOLUTIONS OF SOME MAGNETOGASDYNAMIC AND LAMINAR HEATED JET PROBLEMS. David Clark Smith. Thesis, Evanston, Ill., Northwestern Univ., 1964. 103p.

The laminar, compressible two-dimensional and axially symmetric jets are solved analytically for a variable viscosity and an arbitrary Prandtl number. The flow is assumed subsonic where compressibility is due to heating only. The viscosity is assumed to be linear with temperature for the two-dimensional jet solution. For the axially symmetric jet solution the viscosity is assumed proportional to temperature to the one-half. The two-dimensional jet is also solved for any Mach number for a unitary Prandtl number. The laminar, heated, two-dimensional jet of an electrically conducting fluid with an applied transverse magnetic field is solved by a perturbation technique for subsonic flow. The perturbation parameter is the nondimensional ratio of the magnetic force to the inertia force of the jet. The velocity and temperature distributions are found in closed form to first order in the perturbation parameter. The velocity profiles are also obtained, to first order, for an electric field applied in a direction normal to both the magnetic field and the axial direction. The solution is valid for an electric field that is the same order of magnitude as the v X B force. Both the laminar and turbulent incompressible jets of an electrically conducting fluid with an applied transverse magnetic field are solved by the same type of perturbation technique. An analytical solution is obtained to first order in the interaction parameter. Prandtl's mixing length hypothesis is used for momentum transport for the turbulent jet. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25085 PROCEEDINGS OF THE UNITED NATIONS CONFERENCE ON NEW SOURCES OF ENERGY. SOLAR ENERGY, WIND POWER AND GEOTHERMAL ENERGY, ROME, 21-31 AUGUST 1961. VOLUME 6. SOLAR ENERGY: III. New York, United Nations, 1964. 463p. $5.00. (CONF-610801(Vol. 6))

Papers and reports presented at the 1961 United Nations Conference on New Sources of Energy, relating to the use of solar energy for cooling purposes, for production of fresh water, and for high-temperature processing (solar furnaces), are reviewed and summarized. (L.B.S.)

25086 PROGRESS IN NUCLEAR TECHNIQUES AND INSTRUMENTATION, VOLUME I. F. J. M. Farley, ed. Amsterdam, North-Holland Publishing Company, 1965. 404p.

Separate abstracts were prepared for the six review papers included. (D.C.W.)

For abstracts of individual papers see: 24865, 24866, 24914, 25112, 25113, and 25114.

25087 CONTROL OF A CONTINUUM ELECTROMECHANICAL INSTABILITY. James R. Melcher. 60p. (CONF-641119-3)

From American Physical Society, Division of Fluid Dynamics, Pasadena, Calif.

The stabilization of continuum mechanical and electromechanical systems by means of coupling to active distributed structures is an application of continuum feedback control that has promise. The stabilization of classic forms of Rayleigh-Taylor type instability with a continuum of feedback is presented. The effect of space-wise sampling on the dynamics is discussed in detail for a typical case in which the instability occurs, because a thin, conducting, liquid or elastic film is stressed by a sufficiently large constant electric field. The stabilizing influence of feedback provided by an external electrostatic structure is presented as it depends on: the effect of longitudinal constraints on the film (fixed ends); the degree of coupling between the film and the feedback structure (proximity); and the effect of space-wise sampling to obtain the feedback signals. The stability conditions are found. It is shown that the sampling interval places an upper bound on both the electric pressure and feedback gain consistent with stability. This bound is given, as it depends on the proximity of the feedback structure and the longitudinal boundaries. (auth)

25088 ION SOURCE OF A DUO-PLASMATRON. Heinz Werner (to VEB Vakutronik). U. S. Patent 3,164,739. Jan. 5, 1965. Filed July 20, 1960.

A duoplasmatron ion source using permanent magnets is patented in which the plasma density is adjustable. Magnetic shunts are arranged next to the operating magnetic flux or magnetic reluctances are arranged in the path of the magnetic flux. The shunts are preferably accessible from the outside and adjustable in operation. By means of the shunts, the unhomogeneous magnetic field of the pole face lens may be regulated to any desired value, and particularly to the optimum value. (A.G.W.)

Accelerators

Refer also to abstract 24853.

25089 (AECD/EP/1) A NOTE ON VAN DE GRAAFF RESEARCH PROGRAMMES FOR ATOMIC ENERGY CENTRE, DACCA. Muhtasham Hussain (Atomic Energy Centre, Dacca (Pakistan). Experimental Physics Div.). Sept. 1964. 20p. Dep.(mn)

Some of the problems involved in the use of the 3-Mv accelerator in nuclear physics research are described. Studies of radiation levels and beam characteristics are considered. The planned research programs in the following areas are discussed: proton scattering, proton resonance reactions, neutron cross sections, neutron reactions, charged particle beams, multiply charged ion beams, neutron diffusion, and deuteron reactions. (D.L.C.)

25090 (BNL-8972) PERSONNEL SECURITY AT THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. R. R. Kassner and W. Livant (Brookhaven National Lab., Upton, N. Y.). [Mar. 10, 1965]. Contract [AT(30-2)-Gen-16]. 6p. (CONF-650306-16). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

The safety and protection of personnel associated with high-energy accelerators is studied, with wpecial emphasis on the radiation hazards involved. General philosophies are considered and the personnel security system existing at the 33-Bev Alternating Gradient Synchrotron at Brookhaven National Laboratory is discussed in some detail. (auth)

25091 (CEAL-1020) BEAM BUMP METHOD OF TARGET ENGAGEMENT. R. J. Averill (Cambridge Electron Accelerator, Mass.). Apr. 1965. Contract AT(30-1)-2076. 16p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For the electron accelerator, a technique was developed for engaging a thin tungsten target, located in a field-free straight section, with a 6-Bev electron beam. A distortion (bump) of the equilibrium orbit of the synchrotron is produced by powering backleg windings on four selected synchrotron magnets in a prescribed way. This method is equally useful for engaging a radially inside or radially outside target. Smooth spills of the electron beam on the target were achieved for periods of 100 to 3000 microseconds at energies of 0.5 to 6.0 Bev. The backleg windings are powered by pulse-forming networks which can be operated asynchronously (e.g. 59 out of 60 pps.) Three such systems exist at the laboratory enabling up to three experimenters to perform experiments at the same time. Each experimenter receives an allotted number of pulses out of the 60 machine pulses which are available each second. (auth)

25092 (LA-DC-6754) NUMERICAL STUDIES OF THE SHAPES OF DRIFT TUBES AND LINAC CAVITIES. Harry C. Hoyt (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 7p. (CONF-650306-37). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

A computer program for calculating the magnetic and electric fields in resonant cavities has been developed. This program, LALA, will compute the fields in any cavity having cylindrical symmetry; arbitrary shapes for both drift tubes and external boundaries can be treated. Both π-mode and 2π-mode cavities can be handled. Calculations of several π-mode cavities at about 800 Mc have been carried out. At this frequency, for the π-mode, and in a cavity containing a drift tube, an external conducting boundary having a circular cross section gives about a ten percent increase in ZT^2 from the rectangular external boundary. (auth)

25093 (LA-DC-6779) DESIGN, CONSTRUCTION, AND TESTING OF RF STRUCTURES FOR A PROTON LINEAR ACCELERATOR. E. A. Knapp (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract W-7405-eng-36. 25p. (CONF-650306-40). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

The factors influencing the choice of a r-f accelerating structure for acceleration of protons to high energies in a high-current proton linac are reviewed. Characteristics of resonant periodic cavity chains are described, and the properties of two modes of operation, the π-mode and the $\pi/2$-mode, are discussed. The cloverleaf cavity chain, suitable for use in the π-mode, and four possible configurations suitable for use in the $\pi/2$-mode are described. An accelerator coupling scheme usable in $\pi/2$-mode tank operation is also discussed. Studies of possible fabrication techniques, and the results of a fabricational program utilizing machined forgings to produce a cloverleaf chain are described. Sparking and electron acceleration tests are also briefly mentioned. (auth)

25094 (ORNL-P-1131) RESIDUAL RADIATION STUDIES. C. B. Fulmer, K. S. Toth (Oak Ridge National Lab., Tenn.); and M. Barbier (European Organization for Nuclear Research, Geneva (Switzerland)). [1964]. Contract W-7405-eng-26. 8p. (CONF-650306-54). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Studies of residual radiation levels to be encountered in high-beam-intensity accelerators are reported. Calculated residual radiation decay curves are compared with experimental data. Work with 600-Mev protons is extended to a wider range of bombardment times. The experimental and calculated decay curves for C, Al, Fe, and Cu are compared by normalizing the intensities of the ^{22}Na activity in the aluminum. The experimental and calculated decay curves agree within a factor of 2 or 3 over a range of cooling times for bombardment times that range from 3 hrs to 2 years. Data obtained from one group of samples exposed to 19- to 26-Bev protons for 5 months are also compared with the calculated decay curves. (auth)

25095 (ORNL-P-1133) A LOW-ENERGY SEPARATED-ORBIT CYCLOTRON. E. D. Hudson, R. S. Lord, and R. E. Worsham (Oak Ridge National Lab., Tenn.). [1963]. Con-

tract W-7405-eng-26. 7p. (CONF-650306-51). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Acceleration in the separated orbit cyclotron is achieved by r-f cavities placed at equal angular intervals about a ring of alternating gradient guide field magnets wrapped in a flat spiral. Coaxial cavities with two accelerating gaps and having voltage uniform with radius appear to be more economical than tapered rectangular cavities, for machines up to 100 Mev. Deuterons and alpha particles can also be accelerated in a proton machine by operating it on a harmonic number differing by a factor of two. About 5% adjustment in magnetic field is necessary to correct H_ρ when β_p is twice β_d. (auth)

25096 (ORNL-P-1135) MAGNET FOR AN 800-Mev SEPARATED-ORBIT CYCLOTRON. R. S. Lord and E. D. Hudson (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 6p. (CONF-650306-53). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

The separated orbit cyclotron consists of individual sector magnets and r-f cavities placed alternately in a circular arrangement. The beam is bent and focused by alternating gradient fields produced by pole tips with a minimum radial spacing of 4.5 inches. Magnet design and construction problems are minimized by using the same pole-surface contour and the same mean-field intensity throughout the entire machine. All pole tips in one sector are mounted on a common yoke and driven by a common pair of coils. Shimming gaps are provided between the yoke and the pole tips so that the same mean field intensity can be achieved for all orbits. Only the azimuthal length of the poles is changed to maintain the correct focusing and bending properties of the magnets. (auth)

25097 (ORNL-P-1137) IMPROVEMENTS IN THE ORIC RF SYSTEM. S. W. Mosko and N. F. Ziegler (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 5p. (CONF-650306-55). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

The isochronous cyclotron has been operating since January 1963. Initial experience with the r-f system was enlivened by destructive sparking and general instability at the upper end of the r-f tuning range. A network of protective devices developed during the past two years almost eliminates spark damage and improves the stability of the system. A multistage r-f voltage regulator was also developed and installed. (auth)

25098 (ORNL-P-1148) STABILITY AND TOLERANCES OF THE SEPARATED-ORBIT CYCLOTRON. R. E. Worsham (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 6p. (CONF-650306-57). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

The physical arrangement of the magnets and r-f cavities in a separated orbit cyclotron are described, and the equations of motion and their solution are discussed. The stability limits are determined for triplet and singlet lens systems, and the choice of operating values to give maximum acceptance are examined. The treatment of random misalignment errors of the magnets is described; the six types of errors whose relative strengths are compared lead to bench alignment errors of ~1 mil. The alignment of adjacent lenses and alignment over a distance long compared with a betatron oscillation wavelength are shown, however, to have relatively relaxed tolerances. (auth)

25099 (SLAC-34) TWO-MILE ACCELERATOR PROJECT QUARTERLY STATUS REPORT, JULY 1–SEPTEMBER 30, 1964. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Jan. 1965. Contracts AT(04-3)-400 and AT(04-3)-515. 117p. Dep.; $2.50(cy), 3(mn) CFSTI.

Design and development of the Stanford Linear Accelerator Center (SLAC) and the two-mile linear electron accelerator are summarized. Work by the SLAC staff at other accelerators, research-equipment development programs, and advanced accelerator research are reported. The information is presented in sections on plant engineering, systems engineering, accelerator physics, instrumentation, heavy electronics, plant mechanical design and fabrication, klystron studies, Mark IV accelerator operation, beam switching, and pre-operations research and development. (J.R.D.)

25100 (UCRL-11801) FERRITE MEASUREMENTS FOR SYNCHROTRON RF ACCELERATING SYSTEM DESIGN. Quentin A. Kerns, Gerald S. Tool, and Joseph E. Katz (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1965. Contract W-7405-eng-48. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Ferrites provide a reliable and flexible means of electronically tuning particle-accelerator r-f cavities without wasting a disproportionate amount of r-f power. A systematic design procedure is presented for a ferrite-tuned r-f resonator. Radiofrequency considerations, and use of salient ferrite parameters are the prime considerations of the design example. Using requirements set forth in the r-f design, a bias supply design is discussed with respect to optimization of overall system design. (auth)

25101 (UCRL-11812) MAGNET PLUNGING SYSTEM FOR THE BEVATRON EXTERNAL PROTON BEAM. Roland Krevitt and Donald Morris (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1, 1965. Contract W-7405-eng-48. 13p. (CONF-650306-26). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

An external proton beam was created for the Bevatron. The equipment necessary to produce this beam was designed, fabricated, and installed. (auth)

25102 (UCRL-11935) BEVATRON OPERATION AND DEVELOPMENT. 43, JULY–SEPTEMBER 1964. Robert W. Allison, Jr., Kenneth C. Crebbin, William L. Everette, and Emery Zajec (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 12, 1965. Contract W-7405-eng-48. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

The Bevatron beam was on for 87.1% of the scheduled operating time. A loss in efficiency of injected-beam pickup was caused by a shorted turn in one of the inflector magnets. This caused some jitter in normal beam operation until the magnet was replaced during a scheduled shutdown. Two primary experiments ended, and installation was started on three new primary experiments. Injector studies showed a misalignment of the injector beam-transport system. The injector was realigned during the shutdown. The external proton beam channel was extended to the third focus. (auth)

25103 (UCRL-11952) BEVATRON EXPERIMENTAL AND EXTERNAL-PROTON-BEAM MAGNET POWER-SUPPLY SYSTEMS. Leslie T. Jackson (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 10, 1965. Contract W-7405-eng-48. 26p. Dep.; $2.00(CFSTI).

Magnet power-supply systems for both experimental and external-proton-beam (EPB) magnets used at the Bevatron are described as feedback control systems. Individual components contained in the systems are also described. The power-controlling component first used in the supplies was a three-phase magnetic amplifier. Silicon-controlled-rectifier (SCR) bridges are being used now. The requirements placed on the experimental magnet supply systems are ±0.1% current regulation with ±10% line-voltage perturbations occurring every pulse of the Bevatron. The EPB systems must track to at least ±0.1% a dynamic signal closely related to the proton beam energy. The performance criteria for EPB systems involve both error coefficients and transient response. These supplies are all in the 100-kw range at 1000 A or more. Operational amplifier techniques are used in tailoring the dynamic characteristics of the systems. The

magnet current is monitored by a transductor, a magnetic device providing high-level voltage signals proportional to current with wide bandwidth, d-c isolation, and temperature stability. (auth)

25104 PERIODIC FOCUSING OF DENSE ELECTRON BEAMS WITH THIN LENSES. M. Szilagyi (Research Inst. for Technical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 18: 87-99(1965).

The stability of an axially symmetric dense electron beam, focused by means of a periodic series of thin lenses is considered. The results obtained are different from those given by Pierce. The periodic focusing of a sheet electron beam by means of thin cylindrical lenses is then investigated. The required value of the focal length of the lenses is determined. It is found that this kind of focusing is stable. (auth)

25105 MICROTRON AND ITS APPLICATIONS. S. P. Kapitsa. At. Energ. (USSR), 18: 203-9(Mar. 1965). (In Russian)

A short survey is given of the development of a high current beam microtron. Comparisons are made of this new type electron accelerator with other mean energy electron accelerators. The scientific and technological fields of the microtron applications are discussed. (tr-auth)

25106 ACCELERATOR WITH A NON-LINEAR SPIRAL FOCUSING. V. V. Vecheslavov and Yu. F. Orlov. At. Energ. (USSR), 18: 209-13(Mar. 1965). (In Russian)

The theory of non-linear spiral focusing accelerators was studied, and basic formulas were developed for the case of a cubical focusing. Approximate calculations were made of the stability region, adiabatic damping, mechanism of transverse autophasing, and effects of perturbations. The quantitative accelerator efficiency is identical to the ordinary hard focusing accelerators. (tr-auth)

25107 ION BEAM INJECTION INTO A CYCLOTRON. V. A. Gladyshev, L. N. Katsaurov, A. N. Kuznetsov, L. P. Martynova, and E. M. Moroz. At. Energ. (USSR), 18: 213-18(Mar. 1965). (In Russian)

Descriptions are given of external ion injection into sector cyclotron. The ion beam was injected into a median plane of a magnetic field and without losses reached the accelerating area between the dees. (tr-auth)

25108 EXPERIMENTAL VERIFICATION OF THE POSSIBILITY OF USING DOWEL DELAYING SYSTEMS IN ACCELERATION TECHNIQUES. P. I. Gos'kov. At. Energ. (USSR), 18: 275-6(Mar. 1965). (In Russian)

Experiments with a dowel delaying system in a 10-Mev waveguide electron synchrotron were carried out by the method of small perturbations of bodies in the center of the space between two series of the dowel system. The results showed that for small delays the dowel delaying system seemed highly efficient and can be recommended for use in acceleration techniques. (R.V.J.)

25109 SIFTING HIGH-ENERGY PARTICLES. CERN Courier, 5: 35-7(Mar. 1965).

The use of magnetic beam collimators and electrostatic beam separators is reviewed. The principles of the use of r-f electromagnetic fields and cavities for separating particles of different mass from a beam of particles all having the same momentum are explained. The history of the development of the CERN r-f separator and its performance are briefly discussed. (M.J.T.)

25110 A SOURCE OF LITHIUM IONS. P. Bretonneau and M. Dumail (Faculte des Sciences, Orsay, France). Nucl. Instr. Methods, 33: 167-8(Mar. 1, 1965). (In French)

A lithium ion source adapted to an electrostatic accelerator was developed, using β encryptite as the lithium emitter. The source optics and the development and design of the emitting filament are described. A current higher than 50 μamp for a temperature of the β encryptite of the order of 1200°C was obtained. (J.S.R.)

25111 RESONANT EXTRACTION FROM THE 1 Gev FRASCATI ELECTRON SYNCHROTRON. U. Bizzarri and A. Turrin (CNEN, Frascati, Italy). Nuovo Cimento (10), 37: 751-2(May 16, 1965).

A description is given of the method used for resonant extraction of the 1-Bev electron beam from the Frascati Constant Gradient Synchrotron. The beam characteristics are also discussed. (C.E.S.)

25112 SECTOR FOCUSING CYCLOTRONS. J. Reginald Richardson (Univ. of California, Los Angeles). p.1-101 of "Progress in Nuclear Techniques and Instrumentation, Vol. I." Amsterdam, North-Holland Publishing Co., 1965.

A review on sector-focusing cyclotrons is presented, covering design principles, r-f systems, resonances, beam properties, beam extraction, and acceleration of negative ions. The main features of sector-focusing cyclotrons in use, under construction, and in the design stage are tabulated. 110 references. (D.C.W.)

25113 POLARIZED ION SOURCES AND THE ACCELERATION OF POLARIZED BEAMS. J. M. Dickson (Rutherford High Energy Lab., Chilton, Berks, Eng.). p.103-71 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965.

A review on the atomic-beam physics of polarized ion sources is presented, with consideration of the design of source components. The design parameters and performance of operating sources are compared, and difficulties in the acceleration of polarized beams are discussed. 103 references. (D.C.W.)

25114 POLARIZED TARGETS. Gilbert Shapiro (Univ. of California, Berkeley). p.173-220 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965.

Methods of obtaining and measuring nuclear polarization in targets are reviewed, and the construction and operation of a lanthanum magnesium nitrate target in use at Lawrence Radiation Laboratory since 1962 are described. Some hydrogenous materials for polarized targets are briefly discussed, together with the separation of hydrogen events from background. 70 references. (D.C.W.)

25115 PROBE PLUNGER: MARK IV (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Berkeley). 115 drawings. (CAPE-983)

A pneumatically operated plunger used to translate targets into and out of the aperture at the Bevatron Experimental Facility is described. The device may also be used for all general target applications. (For details, see TID-4100). (D.C.W.)

25116 IMPROVEMENTS IN OR RELATING TO PARTICLE ACCELERATING TUBES. William Douglas Allen, Albert Edward Pyrah, and John Henry Partridge (to National Inst. for Research in Nuclear Science and United Kingdom Atomic Energy Authority). British Patent 967,963. Aug. 26, 1964. Filed Aug. 11, 1961.

A linear particle accelerating tube, suitable for use with an electrostatic generator, comprises two groups of a plurality of electrodes. The planar region adjacent to the beam of one plurality of electrodes is normal to the tube axis. The planar region adjacent to the beam of the following plurality of electrodes is tilted relative to a plane normal to the tube axis. The azimuthal direction of tilt of successive electrodes is incrementally varied to form at least one pair of consecutive 360° spirals spiralling in opposite directions. The increments of tilt are such that the net displacement and angular deviation of the beam in transversing the pair of spirals are substantially zero. (B.L.M.)

25117 IMPROVEMENTS IN OR RELATING TO ION SOURCES. James David London Hedley Wood (to United Kingdom Atomic Energy Authority). British Patent 976,664. Dec. 2, 1964. Filed Feb. 20, 1962.

The ion source dispenses with the usual magnetic field

and depends on an electric field to prevent charged particles escaping and diffusing to the walls of the source and to constrain the direction of movement of electrons. The source comprises a cathode, an extractor cathode spaced from the cathode and having an aperture therein, and an anode spaced between the cathode and extractor cathode so that a gap exists between each. The cathodes determine the length of the plasma, and the anode determines its width. For applying the electric field to the gap between the cathode and anode, a screen electrode negative with respect to the cathodes is positioned about the cathode and external to the plasma and extends in a direction toward the extractor cathode. (B.L.M.)

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Refer also to abstracts 25151, 25195, 25201, 25206, 25212, 25214, 25215, 25217, 25219, 25227, 25228, 25230, 25240, and 25564.

25118 THE POYNTING VECTOR IN MAGNETOHYDRODYNAMICS. Elihu Boldt (Goddard Space Flight Center, Greenbelt, Md.). Am. J. Phys., 33: 298-300(Apr. 1965).

The propagation of electromagnetic energy arising from MHD disturbances is described by a general Poynting vector, valid for perturbations of any magnitude. The Poynting vector associated with the solar wind is specified, and its magnitude is shown to be of the order of 6 $\mu w/m^2$ at the orbit of earth. (auth)

25119 LOCAL IRREGULARITIES IN AN EXPANDING UNIVERSE. William M. Irvine (Harvard Coll. Observatory, Cambridge, Mass. and Smithsonian Astrophysical Observatory, Cambridge, Mass.). Ann. Phys. (N. Y.), 32: 322-47(Apr. 1965).

Einstein's theory of gravitation is here applied to a model of the universe in which local irregularities ($h_{\mu\nu}$) in the space-time metric are superimposed on the values appropriate to a uniform, isotropic universe. The mass tensor is taken to be that of a perfect fluid. The mass density is considered to fluctuate about a mean ρ_0, the density in the uniform model, but the fluctuations need not be small with respect to ρ_0. The effect of pressure is included. The system of simultaneous equations derived by Lanczos, which relates the irregularities in the metric to the irregularities in the mass tensor, is shown to simplify under conditions of astronomical interest. A generalized Poisson equation for h_{44} results, in which only the fluctuating component of the mass tensor appears. The solution is obtained with the aid of Green's function found by Whittaker, which reduces to the familiar form if space is flat. The equation of motion for the irregularities is derived in comoving coordinates. The fourth component of this equation leads to an energy equation involving the kinetic and potential energies of the irregularities and excluding the expanding substratum. This equation should be of significance to cosmogony. The relation of the local inertial coordinate system to the comoving system is examined. An approximate inertial system may be defined in a spatial region within which the square of the expansion velocity is much less than c^2; the expansion velocity need not be small relative to random local velocities. The local inertial system is determined by, and is nonrotating with respect to, the cosmic distribution of matter, so that Mach's principle is satisfied. The equation of motion in the inertial system is derived. Its validity is not restricted to small pressures. For a particle at distance L from the chosen origin only the fluctuating component of ρ at radii greater than L contributes to the gravitational force, while the total density within this radius has a gravitational effect. When the pressure may be neglected, the equation reduces to Newton's law of gravitation. The inclusion of steady-state cosmology within general relativity appears to lead to inadmissible results when local irregularities are present. Expressions for the cosmic pressure, density, and internal energy are derived in terms of local fluctuations in ρ and velocity p_0 has the form that would be expected from the kinetic theory of fluids. The relation between cosmology and cosmogony is discussed. (auth)

25120 ON THE PROBLEM OF THE STRUCTURE OF THE MAGNETIC FIELD IN THE CONVECTION ZONE OF THE SUN. N. I. Kozhevnikov. Astron. Zh., 42: No. 1, 78-85(1965).

The structure of the solar magnetic field in the depths of the photosphere is unknown and it can be analyzed only by phenomena observed on the surface. Groups of sunspots with their diverse features are parameters of the structure of the magnetic field during the cycle of solar activity. Two models of the position of the magnetic field in the convection zone are given: the magnetic field is located at the bottom of the zone; and the magnetic field is distributed through the whole thickness of the convection zone. According to the first model, the magnetic field is carried up to the surface by convective flows. In the second model, the magnetic field varies in intensity during the cycle of solar activity. A convective element rises to the level of the homogeneous atmosphere with the magnetic lines of force frozen in the matter. It is cooled by an adiabatic process. An initial magnetic field of high intensity attains a higher level than a field of lower intensity. Changes in the magnetic field at the bottom of the convection zone may be connected with changes in solar activity during the cycle. Under such conditions, sunspots with the same area must be associated with higher magnetic intensity during the maximum of solar activity than during its minimum. Small sunspot groups may be formed during the maximum of solar activity when residual magnetism exists on the surface of the photosphere. Large sunspots appear in the period of minimum activity. Graphs were drawn which characterize the distribution of sunspots according to the area of spots and the intensity of their magnetic fields. These curves show an increase in the intensity of the magnetic field in the period of maximum activity and a decrease during minimum activity. Another set of curves show that spots with large areas occur in periods without residual magnetism in the photospheric surface. This is evidence in favor of the first model. (CFSTI)

25121 PREDICTION OF PROBABILITY OF OCCURRENCE OF SOLAR FLARES. James B. Weddell (North American Aviation, Inc., Downey, Calif.). Astronaut. Acta, 10: 339-48(1964).

A statistical method was developed by which large solar flares may be predicted from 21 to 35 days in advance. The characteristics of each calcium plage region on each passage across the solar disk were correlated with the occurrence of flares at the regions on the following passage. The probability of occurrence of one or more flares with area at least 100 millionths of the solar hemisphere was determined as a function of the area, brightness, and age of a plage region. Based on data for 984 major flares occurring during 1957—60, the present analysis shows that 75% of the flares were associated with regions which had made at least one previous disk passage. Flares associated with newly formed plage regions were shown to be predictable in some cases from the behavior of magnetically active regions which are observable before appearance of plages. A new condition of the longitudinal component of the magnetic field favorable to later occurrence of flares was found. This condition supplements the conditions established by Severnyi, who observed that this field component is zero, but has a large gradient, on the photosphere beneath the points of origin of most major flares. In the present study it was shown that if a point at which Severnyi's conditions exist has no proper motion relative to the photosphere for three days or longer, then occurrence of flares above this point is favored during the following disk passage of the region. If the correlations of flares with plage regions and magnetic configurations are combined in a flare prediction method, the expectation that a prediction will be correct is 0.78 and the expectation of a "false flare alarm" is 0.11. (auth)

25122 STUDIES OF SOLAR PROTONS WITH EXPLORERS XII AND XIV. D. A. Bryant, T. L. Cline, U. D. Desai, and F. B. McDonald (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 141: 478-99(Feb. 15, 1965).

Four solar proton events observed by Explorers XII and XIV in 1961 and 1962 are discussed. These events are directly associated with solar activity and, in three cases, are followed either by secondary events delayed by about 2 days or by recurrent events on succeeding solar rotations. It is shown that the rate of propagation of solar protons is, in some of the primary events, linearly dependent on particle velocity. For example, the time taken to reach maximum intensity is inversely proportional to velocity. It follows that the mode of propagation (as measured by the distance traveled in reaching the Earth, for example) is independent of velocity. This result makes possible a separation of source characteristics from propagation effects. In each event which shows a velocity dependence, the maximum intensity is reached long after the rectilinear travel time. It is concluded from this that propagation involves an important degree of scattering and that the degree of scattering is independent of energy over the observed range of 1.4 to 500 Mev. The energy spectrum at the time of escape from the Sun, the "source spectrum," is determined in each event which shows a velocity dependence. In each case it is a power law in kinetic energy from a few Mev to several hundred Mev. All events show periodic fluctuations in intensity, which are simultaneous at all energies and have a period of from 1 to 1.5 hours depending on the event. The lack of dispersion indicates the existence of a periodic structure either in the solar wind or in the region between the magnetosphere and the Earth's shock front. (auth)

25123 LONGITUDE DISTRIBUTION OF PROTON FLARES. Constance S. Warwick (National Bureau of Standards, Boulder, Colo.). Astrophys. J., 141: 500-4 (Feb. 15, 1965).

Energetic protons that cause polar-cap absorption (PCA) come from flares that cluster in certain preferred heliographic longitudes. This clumping of great flares at locations that are fixed in a rigidly rotating system is distinct from the recurrence or revival of individual long-lived active regions. The clustering of PCA flares is related to the clustering of optical solar activity found by Trotter and Billings in cycle 19, but the grouping of PCA flares is much sharper. The results of sunspot studies by Losh and by Vitinskii are shown to be consistent with each other when both are presented in the same form. (auth)

25124 LOOP PROMINENCES AND CORONAL CONDENSATIONS. II. THE SOURCE OF MASS AND ENERGY AND A MODEL OF THE LOOP PROMINENCE MECHANISM. J. T. Jefferies (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.) and F. Q. Orrall. Astrophys. J., 141: 519-25(Feb. 15, 1965).

Estimates of the mass and energy requirements of loop prominences indicate difficulties in the generally accepted condensation process. An alternative process is considered in which superthermal particles drift or are injected into the magnetic field of the loop. It is found that all the mass required to maintain a loop (or quiescent) prominence can be supplied in the form of particles moving at 10^8 cm/sec and that their energy will then just balance that lost by radiation. Since it is now known that loop prominences are associated with those flares that produce copious amounts of fast plasma, it is suggested that the loops arise naturally as a coronal configuration by which this flare plasma is returned to the chromosphere. The mass and energy required to feed the loop system are provided by the injection into the system of fast particles of this plasma. The applicability of this mechanism to other types of prominences is discussed. (auth)

25125 ON THE SOLUTIONS OF PARKER'S HYDRODYNAMIC THEORY OF SOLAR AND STELLAR WINDS. R. L. Carovillano and J. H. King (Boston Coll., Chestnut Hill, Mass.). Astrophys. J., 141: 526-33(Feb. 15, 1965).

The mathematical features of the non-linear hydrodynamic equations of Parker's model of solar and stellar winds are investigated in an alternative manner to that used by Parker. The analysis presented here systematically enumerates and studies all possible mathematical solutions of the basic equations, and clearly shows that no physically relevant solutions were neglected by Parker in his original analysis. Upon application of boundary conditions at the base of the corona and at large radial distances, the model predicts that, for given coronal base temperature and temperature gradient, only one stationary-state solution, the critical curve, is physically acceptable. It is emphasized that the unique character of the critical curve necessitates an analysis of this curve for its stability properties. (auth)

25126 ON THE MAGNETO-HYDROSTATIC THEORY OF SUNSPOTS. Willi Deinzer (Goddard Space Flight Center, New York). Astrophys. J., 141: 548-63(Feb. 15, 1965).

Theoretical sunspot models are constructed which are a generalization of those considered by Schlüter and Temesvary (1958). A non-vanishing horizontal component of the pressure gradient, as required by magneto-hydrostatic equilibrium, is obtained by assuming that a magnetic field in the solar hydrogen convection zone (HCZ) inhibits the convective-energy transport. In the framework of Prandtl's mixing-length theory, this is achieved by making the ratio of the mixing length, l, and the pressure scale height, H, smaller in the magnetic-field region than in the surrounding undisturbed HCZ. The corresponding system of ordinary differential equations was solved numerically, and pressure, temperature, and magnetic-field strength along the axis of symmetry were obtained. When l/H ranges from zero to $(l/H)_{HCZ}$ a one-parameter family of solutions results; in the one extreme convective-energy transport is completely suppressed; in the other extreme there is no inhibition of convective-energy transport. From this family of models, relations between the coolness of a spot and its magnetic-field strength and between the magnetic-field strength and l/H are derived. The former relation agrees with observations to within 50 per cent; the latter indicates a maximum possible field strength of about 5000 gauss. (auth)

25127 A SEARCH FOR DEUTERIUM IN STELLAR SPECTRA. I. MAGNETIC STARS. Manuel Peimbert and George Wallerstein (Univ. of California, Berkeley). Astrophys. J. 141: 582-7(Feb. 15, 1965).

A search for the deuterium component of Hα on twenty-five 8-Å/mm spectrograms of nine magnetic stars has yielded negative results. One spectrum of α^2 CVn shows a Dα feature, but three other plates do not. HR 710 also shows a Dα line on one plate, but a second spectrum taken on a very dry night shows nothing. None of the other stars shows any indication of the presence of deuterium. Model atmospheres have been used to derive upper limits for the ratio of D/H. The upper limits range from 7×10^{-4} to 4×10^{-5} depending on the number of plates available and the physical conditions in the stellar atmospheres. (auth)

25128 APPROACH TO EQUILIBRIUM IN THE CNO BI-CYCLE. Georgeanne R. Caughlan (Montana State Coll., Bozeman, Mont.). Astrophys. J., 141: 688-717(Feb. 15, 1965).

Differential equations of the CNO bi-cycle are solved to obtain the abundances of carbon, nitrogen, and oxygen nuclei as functions of protons consumed per initial nucleus for hydrogen burning in the temperature range $10-50 \times 10^6$°K. General features of the curves of abundance ratios for ^{12}C, ^{13}C, ^{14}N, ^{15}N, and ^{16}O nuclei as functions of protons consumed are found to be insensitive to the temperature at which the reactions take place. The resonance at 65 kev in the $^{17}O(p,\alpha)^{14}N$ reaction is responsible for the temperature dependence of ratios involving ^{17}O nuclei. Analysis is made of the effect of convection with microscopic mixing on CN material passing through a hydrogen-burning zone. If a simple linear relationship or a sinusoidal relationship is assumed for the time dependence of temperature, the ratios of abundances attained at the surface in a given time are

the same whether the time is spent in a single transit to the surface or in several transits back and forth from the bottom of the hydrogen-burning zone to the surface of the star. It is shown that the $^{13}C-^{12}C$ ratio observed in typical carbon stars can be explained on the basis of the CNO bi-cycle if the time spent in the process is at least one-half the mean lifetime of ^{12}C for proton capture, but that, in order to explain the ratio of nitrogen to oxygen suggested by astromers for these stars, it is necessary to assume that the time spent by the nuclei at the site of hydrogen burning must be no longer than the mean lifetime of ^{12}C for proton capture. In the Appendix a table is given of contributions of several resonant levels in the compound nuclei involved in the proton-capture reactions of ^{12}C, ^{13}C, and ^{14}N. These contributions are presented in the form of equations for the temperature dependence of the mean lifetimes of the reactions. (auth)

25129 ON THE CORONAL TEMPERATURE. John C. Brandt, Richard W. Michie, and Joseph P. Cassinelli (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 141: 809-11(Feb. 15, 1965).

The discrepancies which exist in determinations of the coronal temperature by Doppler line broadening, scale heights, ionization data, and radio brightness-temperature measurements are pointed out, and it is shown that the scale heights for coronal electron densities are consistent with the temperature obtained from Doppler line broadening, provided the coronal fine structure is taken into account. (L.B.S.)

25130 THE CONTINUOUS ABSORPTION COEFFICIENT OF He^-. W. B. Somerville (University Coll., London). Astrophys. J., 141: 811-14(Feb. 15, 1965).

Calculations are made of the continuous absorption coefficient for free-free absorption by He^-, and the results are tabulated. A rough calculation of the opacities due to free-free absorption by helium as compared to hydrogen indicates that in the atmospheres of cooler stars the contribution from He^- is far from negligible. (L.B.S.)

25131 A REMARK CONCERNING GOLDBERG'S "THE ABUNDANCE OF He^3 IN THE SUN." Osamu Namba (Sterrewacht "Sonnenborgh", Utrecht). Astrophys. J., 141: 827-8(Feb. 15, 1965).

An interpretation by Goldberg of the line profiles of the infrared He I line in a facula and in the normal photosphere led to an estimate of ≤ 0.018 for the abundance ratio of $^3He/^4He$. An improved upper limit of $\leq 0.010 \pm 0.005$ was estimated for the isotope ratio. (L.B.S.)

25132 CORONAL POLAR RAYS AND POLAR MAGNETIC FIELDS. J. W. Harvey (Lockheed-California Co., Burbank). Astrophys. J., 141: 832-4(Feb. 15, 1965).

Superposed K_3 spectroheliograms and corona photographs were used to study the local distribution and intensity of polar magnetic fields. The K_3 and corona intensities were obtained as functions of limb position angle for the north and south pole from microdensitometer scans, and the resulting curves are shown. (L.B.S.)

25133 MAGNETOTURBULENCE AND ASTRONOMY. I. THE NATURE AND ORIGIN OF NON-THERMAL RADIO SOURCES. David Layzer (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 141: 837-43(Feb. 15, 1965).

A hypothesis on the properties of a turbulent magnetic field in a highly conducting plasma is outlined, which gives a unified account of explosive events that produce synchrotron radiation and cosmic rays and explains why superstars are so efficient in this respect. It also offers a solution of the angular momentum difficulty that applies to ordinary stars as well as to superstars, suggests an explanation of certain geometrical properties of supernova remnants and radio galaxies, and offers a clue to the interpretation of some well-known anomalies in the relative abundances of primary cosmic-ray nuclei. (L.B.S.)

25134 SPACE TRAVEL AND EXPLORATION. IV. SCIENTIFIC RESULTS: THE SUN AND SOLAR-TERRESTRIAL RELATIONS: SHORT-WAVE ASTRONOMY. Harrie Massey (University Coll., London). Contemp. Phys., 6: 172-91(Feb. 1965).

A brief account is given of some of the techniques used and the results obtained in the study of solar radiation by space vehicles. Electromagnetic and corpuscular radiation and their terrestrial effects are considered. The progress made in establishing a new branch of short wave (ultraviolet and x-ray) general astronomy is briefly mentioned. (L.B.S.)

25135 CHARACTERISTICS OF THE X-RADIATION OF PROTON FLARES. A. S. Dvoryashin (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 497-503(1964).

The temporal pattern of ionospheric effects was studied in relation to proton flares. There was found to be a hardening of the x-ray spectrum of a number of proton flares. It is postulated that this is bremsstrahlung from high-energy electrons in the dense layers of the chromosphere (nonequilibrium radiation). The production of very hard x-ray photons and their relation to strong radio emission bursts on centimeter waves shows that these bursts probably are due to the synchrotron radiation of electrons accelerated in the magnetic fields of an active region. In the case of a number of strong proton flares it was observed that there is emission of x radiation from the active region after the luminescence of the flare in H_α has virtually disappeared. It is concluded that this is equilibrium radiation and that its source is plasma localized in coronal condensations. The fact that the spot or the penumbra of the spot is covered by H_α luminescence near the time of maximum of the flare is evidence that the agent exciting the luminescence is localized in the magnetic field. Since the maximum of the radio emission burst, from synchrontron radiation, is attained at this same time on centimeter waves, the nonstationary process leading to acceleration of particles and the heating of plasma is localized in magnetic fields. (auth)

25136 SOME CHARACTERISTICS OF RADIO EMISSION SOURCES ON THE SUN ASSOCIATED WITH SPOT GROUPS. A. S. Grebenskii and A. P. Molchanov (Leningrad State Univ.). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 504-9(1964).

On the basis of a study of two limiting models of the distribution of temperature and the electron concentration of an active region most favorable for the effectiveness of the bremsstrahlung mechanism, it is shown that the synchrotron radiation mechanism plays the principal role in the range of wavelengths $2 \text{ cm} < \lambda < 20 \text{ cm}$. In order to explain the characteristics of radiation, it is necessary to assume the presence of a magnetic field with a strength of more than 1000 gauss at a height of 10 to 20×10^3 km above the photosphere for any thermal radiation mechanism. The importance of the model of the magnetic field of the radio emission source is pointed out. The formulas are given for computation of the optical thickness of the radiating layer for multiple harmonics of gyrofrequency in the case of a synchrotron mechanism. (auth)

25137 COSMIC EXPLOSIONS. Richard Stothers (Goddard Space Flight Center, New York). Nature, 206: 82 (Apr. 3, 1965).

It is proposed that matter is created preferentially where the density of matter is lowest, due to the fact that universal expansion causes the low density, and that quasi-stellar radio sources are the manifestations of this creation. It is further postulated that matter is created already sharing the universal expansion. (D.C.W.)

25138 SIZE OF A SUPERDENSE STAR AND INTERACTIONS BETWEEN ELEMENTARY PARTICLES. F. Pacini (Laboratorio di Astrofisica, Frascati, Italy and Observatorio Astronomico, Rome). Nuovo Cimento (10), 37: 767-70(May 16, 1965).

The general relation that connects the size of a superdense star composed of an ideal Fermi gas of particles

whose mass is m_2 with the size of another star composed of an ideal Fermi gas of particles of mass m_1. The basic parameters for a star composed of particles of mass m_2 can be computed if the corresponding parameters for the stars composed of particles of mass m_1 are known. This general relation can be used in order to obtain information about the effect of a classical short-range scalar potential function (corresponding to a possible attractive interaction among the particles) on the size of a given superdense star (e.g., a neutron star). (C.E.S.)

25139 THE NEUTRINO IN ASTROPHYSICS. G. Feinberg (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 285: 257-62(Apr. 20, 1965).

In this review, some of the effects which might occur in astrophysical phenomena as a result of possible electromagnetic interactions of neutrinos and of the hypothetical electron-neutrino interaction are considered. (auth)

25140 FOSSIL PARTICLE TRACKS AND URANIUM DISTRIBUTIONS IN MINERALS OF THE VACA MUERTA METEORITE. R. L. Fleischer (General Electric Research Lab., Schenectady, N. Y.), C. W. Naeser, P. B. Price, R. M. Walker, and Ursula B. Marvin. Science, 148: 629-32 (Apr. 20, 1965).

Fossil tracks of charged particles were observed in minerals separated from the Vaca Muerta mesosiderite. Irradiation of samples of the meteorite with thermal neutrons in a nuclear reactor, together with measurements of track-length distribution, indicated that some of the tracks resulted from the spontaneous fission of uranium impurities; others, however, were of different origin. Uranium concentrations, which ranged from about 4000 ppm in a zircon grain to less than 10^{-3} ppm in hypersthene and anorthite, were also measured by irradiating samples with thermal neutrons. (auth)

25141 THE RARE GAS ISOTOPES OF THE CHIEF CONSTITUENTS OF TWO STONE METEORITES. S. Auer, H. J. Braun, and J. Zaehringer (Max-Planck-Institut fur Kernphysik, Heidelberg). Z. Naturforsch., 20a: 156-7 (Jan. 1965). (In German)

Two chondrites, Richardton and Bjurbole, were decomposed into their components, and the rare-gas content and isotopic composition and the K–Ar age were measured for the chondrules, matrix, nickel-iron, and unseparated sample. The results are tabulated and discussed. (J.S.R.)

25142 TRUDY SHEMAKHINSKOI ASTROFIZICHESKOI OBSERVATORII. TOM III. (Reports of the Shemakhinski Astrophysical Observatory. Volume 3). G. F. Sultanov, ed. Baku, Azerbaidzhan SSR, Publishing House of the Academy of Sciences, 1964. 103p.

Five articles are included; a separate abstract was prepared for one. Articles not abstracted are on the increase of brightness of flocculi during chromospheric flares, the mass of a degenerate high-density configuration, spectrophotometry of the unusual solar protuberance of July 2, 1958, and a catalog of the shifts of the central residual intensities and equivalent widths of selected Fraunhofer lines. (M.J.T.)

For an abstract of the individual paper see: 25143.

25143 ON THE RATE OF NUCLEAR REACTIONS IN DENSE MEDIA. Z. F. Seidov. p.25-39 of "Trudy Shemakhinskoi Astrofizicheskoi Observatorii. Tom III." Baku, Azerbaidzhan SSR, Publishing House of the Academy of Sciences, 1964.

A quantitative study is made on the rate of a nuclear reaction in a dense medium, taking into consideration the effect of condensed heavy nuclei, in an attempt to investigate the aggregate condition of white dwarfs. The Kirzhnits model for the medium is used, assuming that the heavy ionized nuclei form a lattice, with one proton per elementary lattice, and that the electrons are an ideal homogeneous gas. The binding of the protons in the lattice is obtained as a function of temperature and density. The rate of the p-p fusion reaction in a condensate and in a plasma and the rate of energy release as a result of the p-p reaction in a dense medium are given as functions of density for temperatures of 5×10^6, 10^7, 2×10^7, and 5×10^{7}°C. (M.J.T.)

25144 HYDROMAGNETIC MODEL SOLAR PROTON EVENT. J. B. Weddell (North American Aviation, Inc., Downey, Calif.). 9p. (CONF-641210-16)

From American Physical Society Meeting, Berkeley, Calif.

The methods used for calculating the number versus energy of protons emerging from hydromagnetic shocks in the solar corona at points directly above the flare are used to determine the emergent proton energy spectrum at points in oblique directions from the flare. The construction of a model of the energy distribution versus time and direction of arrival of protons reaching a receiver in the vicinity of the earth but remote from a geomagnetosphere is described. (L.B.S.)

25145 SPECTRUM OF SOLAR PROTONS EMERGING FROM HYDROMAGNETIC SHOCKS. W. A. Janos and J. B. Weddell (North American Aviation, Inc., Downey, Calif.). 9p. (CONF-641210-14)

From American Physical Society Meeting, Berkeley, Calif.

The energy spectra of protons emerging from shocks at various heliocentric distances were determined from an analysis of the acceleration and scattering of protons by hydromagnetic shock waves in the solar corona. The results can be used in calculations of the time-dependent angular distribution versus energy of protons reaching a given point in space. (L.B.S.)

Atomic Physics

Refer also to abstracts 25130, 25495, and 25521.

25146 (TID-21542) THE DETERMINATION OF LOW-ENERGY X-RAY MASS-ABSORPTION COEFFICIENTS. Final Report, January 1, 1962–October 31, 1964. Randall W. Carter and Robert H. Rohrer (Emory Univ., Atlanta, Ga.). Contract AT(40-1)-2953. 48p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

A series of experiments to measure x-ray absorption at energies below 10 kev is described. Thin-foil Cu, Mn, Ge, Ni, Sc, Ti, V, Fe, Co, and Zn absorbers were studied. The mass coefficients are reported as a function of x-ray energy. A comparison of these data with literature shows a trend toward higher values of mass absorption at energies below 4 kev. The absorption coefficients for wavelengths shorter than the K-edge wave-length fit previously devised empirical formulas. Efforts were made to devise formulas for longer wavelengths. (J.R.D.)

25147 THEORETICAL INTERPRETATION OF SOME PROPERTIES OF THE PERIODIC SYSTEM BY THE THOMAS–FERMI MODEL. A. Konya (Research Inst. of Theoretical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 18: 129-39(1965).

By means of quantities defined in the statistical theory of atoms as analogous quantities to the quantum numbers of wave mechanics, several problems of the atomic shell structure are considered, including the maximal principal quantum number, the first appearance of the principal quantum numbers in the periodic system of the elements, the completion of the electron shells, and the anomalous sequence of the electronic states with higher angular quantum numbers. The Thomas–Fermi model gives a theoretical description for all these characteristic properties of the atomic structure, averaging the discontinuous changes in the periodic system of the elements. (auth)

25148 ELECTRON SCATTERING BY ATOMS AND THE EXISTENCE OF NEGATIVE IONS. T. Tietz (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung., 18: 141-4 (1965).

The phase shifts for electron scattering by neutral atoms near zero energy were calculated using the variational methods of Hulthen, Kohn, and Malik. Numerical results

for a carbon atom confirmed the existence of the C^- ion. (D.C.W.)

25149 EFFECTS OF ATOMIC AND MOLECULAR IMPACTS ON SPACECRAFT. D. McKeown (General Dynamics/Astronautics, San Diego, Calif.), M. G. Fox, and J. J. Schmidt. AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 710-13(Apr. 1965).

Experimental measurements of atomic and molecular impacts on metallic surfaces are described. The measurements were collected in the upper atmosphere from satellites and in the laboratory using molecular-beam techniques at energies ranging between a few ev and several kev. Over this energy range, impacts are important in terms of surface changes they will produce, since the mean penetration depth of these particles is less than 1μ. The erosion produced by impacts in the upper atmosphere was attributed to sputtering. The maximum sputtering rate for a satellite orbiting at 400 km was found to be 50 Å/yr. For craft traveling through the solar plasma, the principal effect of the impacts will be deposition. The yields of protons and alpha particles present in the plasma are too low to produce significant sputtering. For a light metal, such as aluminum, a concentration of embedded hydrogen amounting to 6% can build up over a region extending about a thousand angstroms beneath the surface during long exposure periods. (auth)

25150 TWO-ELECTRON EXCITATION STATES IN HELIUM. R. P. Madden and K. Codling (National Bureau of Standards, Washington, D. C.). Astrophys. J., 141: 346-75(Feb. 15, 1965).

Resonances in the photoionization continuum of helium were observed spectroscopically in the 165–200-Å region using the synchrotron radiation from the NBS 180-Mev electron synchrotron as a background source. Twenty-one resonances were observed, forming four series which can be associated with transitions from the ground state to two-electron excitation states of neutral helium. Two of these series converge onto the n = 2 states of He^+, while the other two converge onto the n = 3 and n = 4 states of He^+, respectively. The observed energies of these resonances are compared with available theoretical estimates. The absorption profile of the strongest resonance, due to the $2s2p\ ^1P^o$ state, was studied in detail and found to be well predicted by theory. (auth)

25151 CONTINUUM STATES OF H^- AND THE FREE-FREE ABSORPTION COEFFICIENT. S. Geltman (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Astrophys. J., 141: 376-94(Feb. 15, 1965).

Variationally determined wave functions for the continuum states of H^- are used to calculate the free-free absorption coefficient. The results for the free-free absorption coefficient are believed to be more accurate than those of other calculations which have been done to date. (auth)

25152 A THEORETICAL STUDY OF LEVEL CROSSING EFFECTS IN ^{23}Na AND ^{85}Rb. J. Kapelewski and K. Rosinski (Univ. of Warsaw). Bull. Acad. Polon. Sci., Math., Astron. Phys., 13: 61-7(1965).

The crossing of atomic energy levels in nonvanishing weak magnetic fields is discussed. The theoretical investigation of parameters describing level crossing in the alkali metals ^{23}Na and ^{85}Rb is described. The magnetic field strengths at which crossing occurs and the half width and relative magnitude of interference signals are presented. (C.E.S.)

25153 DEPENDENCE OF ANGULAR DISTRIBUTION OF SPUTTERING BY POSITIVE IONS FROM METAL TARGETS ON THE IMPACT ANGLE. V. T. Chiplonkar and S. R. Rane (Inst. of Science, Bombay). Indian J. Pure Appl. Phys., 3: 131-5(Apr. 1965).

The nature of the angular distribution of the sputtered atoms produced by bombardment of a plane polycrystalline silver targets with argon positive ions from an r-f ion source and its variation as a function of the impact angle (ϕ) were studied. The sputtered atoms were collected on two cylindrical collectors, collector I in the incident plane and collector II in a plane perpendicular to it. Deposit on collector I showed an angular distribution with a maximum in one preferred direction determined by ϕ. The angular distribution for the deposit on collector II was found to be approximately of the cosine type distribution. The deviation from the cosine type distribution was found to be independent of ϕ. (auth)

25154 GENERALIZED OSCILLATOR STRENGTHS AND ELECTRONIC COLLISION CROSS SECTIONS FOR NITROGEN AT EXCITATION ENERGIES ABOVE 10 ev. S. M. Silverman and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 42: 3420-9(May 15, 1965).

Collision cross sections and generalized oscillator strengths were determined for each of 13 transitions in nitrogen whose excitation energies lie in the interval 10 to 83 ev. Only the generalized oscillator strengths are reported since the collision cross sections can be calculated from these. Incident kinetic energy was approximately 500 v in each case. (auth)

25155 DETERMINATION OF MOLECULAR EXCITATION POTENTIALS BY ELECTRON IMPACT. AN ANOMALY IN THE N_2 SPECTRUM. Edwin N. Lassettre, Frederic M. Glaser, Vincent D. Meyer, and Ausma Skerbele (Ohio State Univ., Columbus). J. Chem. Phys., 42: 3429-35(May 15, 1965).

An improved monochromator is described that provides an electron beam sufficiently homogeneous in energy so that peak widths range from 0.28 v at 400-v kinetic energy to 0.13 v at 150-v kinetic energy. Using this device excitation potentials were determined for CO_2 and N_2. The highest peak in the spectrum of N_2 occurs at an excitation potential of 12.93 v while the most intense transition in the ultraviolet absorption spectrum, according to Huffman, Tanaka, and Larrabee, occurs at 12.74 v. This discrepancy exceeds the experimental error in the determination and indicates a failure of the Born approximation. (auth)

25156 OSCILLATOR STRENGTHS OF SEVERAL PEAKS IN THE ELECTRON-IMPACT SPECTRUM OF CARBON DIOXIDE. SPIN-ORBIT COUPLING. Vincent D. Meyer and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 42: 3436-41(May 15, 1965).

Electron-impact spectra of CO_2 were obtained at incident kinetic energies of 150, 200, 300, and 400 v. Oscillator strengths of four transitions were calculated from the spectra and compared with other denominations. Assignment of term symbols is discussed. (auth)

25157 ENERGY-TRANSFER PROCESSES IN MONOCHROMATICALLY EXCITED IODINE MOLECULES. I. EXPERIMENTAL RESULTS. Jeffrey I. Steinfeld and William Klemperer (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 42: 3475-97(May 15, 1965).

The fluorescence excited in iodine by the green emission line of mercury, in the presence of foreign gases, was examined by high-resolution photoelectric photometry. Cross sections for quenching, vibrational, and rotational energy transfer for the $v' = 25$, $J' = 34$ level of the $B^3\Pi_{0u^+}$ state of iodine were obtained, for collisions with ^{3}He, ^{4}He, Ne, Ar, Kr, Xe, H_2, O_2, CO_2, SO_2, CH_3Cl, and NH_3. Emission bands were rotationally analyzed to yield partial total cross sections for the inelastic processes. These were corrected for multiple scattering by a computer simulation procedure. The correlation of quenching efficiency with the mass and polarizability of the collision partner, found by Brown for the quenching of the $v' = 15$ level of iodine, holds for the $v' = 25$ level as well. There is no contribution to quenching efficiency from a permanent electric dipole moment. The data suggest that a complex set of interactions, including electrostatic polarization, spin-orbit forces, and specific chemical effects, are responsible for quenching, indicating a multiplicity of repulsive states contributing to the induced predissociation process. The vibrational energy-transfer efficiency is maximum when the mean collision time equals the period of oscillation of the molecule, which corresponds to a collision reduced mass $\simeq$40 for T = 370°K, $v' = 25$ of I_2; vibrational transfer is largely independent of the inter-

nal structure of the collision partner. The efficiency of pure rotational energy transfer ($\Delta v' = 0$) shows a similar smooth dependence on reduced mass of the collision system, with the exception of the molecules SO_2, CO_2, and CH_3Cl, which are more efficient. Quantitative measurements were made on partial components of total inelastic cross sections for $\Delta J'$ up to ±20 angular momentum units, with evidence for a total spread of $\Delta J'$ up to 30 or 40. The width of the distribution of partial cross section components decreases in the order $\Delta v' = +2 > -2 \gtrsim +1 > -1 \gg 0$; also, the $\Delta J'$ distribution is broader for collisions with heavier particles. (auth)

25158 HYDROGEN MOLECULAR ION: SOLUTIONS OF THE SCHRÖDINGER EQUATION EXPRESSED AS INTEGRAL EQUATIONS. Paul Caylor McKinney (Wabash Coll., Crawfordsville, Ind.). J. Chem. Phys., 42: 3537-9(May 15, 1965).

The ordinary differential equations that arise from the separation of the Schrödinger equation for the hydrogen molecular ion in prolate spheroidal coordinates were investigated to find exact solutions in the form of integrals. Such solutions were found to be homogeneous Fredholm integral equations of the second kind. Appropriate kernels for the integral equations were explicitly determined and the elementary properties of the wave-equation solutions are discussed. (auth)

25159 NORMALIZATION OF DIFFRACTION DATA FROM LIQUIDS. Aneesur Rahman (Argonne National Lab., Ill.). J. Chem. Phys., 42: 3540-2(May 15, 1965).

In any system, the effective exclusion of an atom from the immediate neighborhood of another atom can be used to derive a necessary (but not sufficient) condition which the diffraction pattern of the system has to satisfy. This condition provides a new method of scaling the observed diffraction data from liquids. The currently available x-ray and neutron-diffraction data on liquid argon at 84°K are found to differ in a systematic manner, and this discrepancy appears to be beyond the experimental uncertainties of the data. It is demonstrated that the above-mentioned condition can be used as a reliability criterion as well. Using this criterion, it was found that the neutron diffraction data are much more reliable. (auth)

25160 QUANTUM-MECHANICAL STUDIES OF SEVERAL HELIUM– LITHIUM INTERACTION POTENTIALS. S. B. Schneiderman and H. H. Michels (United Aircraft Corp., East Hanford, Conn.). J. Chem. Phys., 42: 3706-19(May 15, 1965).

The total energies for a number of states of HeLi were computed using a method of molecular orbital calculation in which the total wavefunction is taken as a linear combination of spatial configurations, each a properly antisymmetrized product of flexible one-electron functions in an elliptic coordinate system. Calculations were performed for the $^2\Sigma$ ground state and a number of excited $^2\Sigma$, $^2\Pi$, $^4\Sigma$, and $^4\Pi$ states of HeLi. The $^1\Sigma$ ground state of the molecular ion $HeLi^+$ was also examined to facilitate an evaluation of the neutral excited states. The lowest $^2\Pi$ and $^4\Pi$ states as well as two highly excited $^2\Sigma$ states were found to be weakly bonding with dissociation energies of less than 1 ev. The importance of configuration interaction upon the accuracy of the calculations was examined and a method of obtaining approximate energies for highly excited states was developed. On the basis of these calculations, it was concluded that the weak bonding evidenced by some of the states of this system is due largely to the effects of orbital geometry and nuclear screening at large internuclear distances. (auth)

25161 LIFETIME STUDIES OF THE RADIATIVE DISSOCIATION OF EXCITED H_2. R. G. Fowler and T. M. Holzberlein (Univ. of Oklahoma, Norman). J. Chem. Phys., 42: 3723-4(May 15, 1965).

The dissociative continuum in hydrogen, resulting from the transition $a^3\Sigma_g^+ - b^3\Sigma_u^+$, is reported. For this transition, the approximate lifetime of 3.5×10^{-8} sec over the wavelength range from 6500 to 3000 Å was found. In addition, a quenching process that appears to be caused by binary collisions with a cross section of about 1.8×10^{-15} cm^2 was observed. The excitation was provided by 5 amps of 100 ev monoenergetic electrons. The absolute intensities of the radiations increased strongly with pressure. (P.C.H.)

25162 ATOMIC ENERGY LEVELS OF NEUTRAL ERBIUM. Louis C. Marquet and Sumner P. Davis (Univ. of California, Berkeley). J. Opt. Soc. Am., 55: 471-4(May 1965).

The wavenumbers of nearly 8000 transitions in Er(I) and Er(II) lying in the visible and near ultraviolet were measured to an estimated accuracy of ±0.015 cm^{-1}. Of these lines, 385 were observed to show self-reversal at extreme excitation conditions. The high precision of the line list, along with these reversal data, led to the identification of the seven lowest levels of the ground configuration of neutral erbium, $4f^{12}6s^2$. Furthermore, the classification of the eight lowest levels in singly ionized erbium, as previously reported was well corroborated, and two more levels were found. (auth)

25163 4fnl CONFIGURATIONS OF DOUBLY IONIZED CERIUM (Ce III). Nissan Spector (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 55: 492-501(May 1965).

A theoretical interpretation is given for the configurations of the type 4fnl of Ce(III). New values for radial parameters were obtained by least-squares. Percentage compositions in the appropriate coupling schemes are given for the energy levels. The rms error is less than 0.7% for most cases. (auth)

25164 VACUUM-ULTRAVIOLET RADIATION FROM RARE GASES IRRADIATED BY GAMMA RAYS. Yukio Mikawa. J. Opt. Soc. Am., 55: 569(May 1965).

A glass chamber containing up to 1 atm of argon was irradiated by gamma rays (25 μC ^{226}Ra) from outside the chamber. A narrow-band-sensitive Geiger counter was installed at an end of the chamber to detect vacuum ultraviolet (vuv). As a result of the sensitivity of the counter an appreciable amount of vuv was detected. The approximate proportionality of the intensity of vuv to the pressure of argon showed that the radiation was from the argon gas itself. The same results were also found with krypton. It seems likely that the gamma photon interacts with an atomic electron of the gas in the initial process. (P.C.H.)

25165 ENERGY LEVELS IN NEUTRAL ERBIUM. L. C. Marquet and W. E. Behring (Goddard Space Flight Center, Greenbelt, Md.). J. Opt. Soc. Am., 55: 576(May 1965).

After an extensive analysis of the $4f^{12}6s^2$ ground configuration, it was found that 76% of the reversed lines remained unclassified. Apparently, a second low-lying configuration of odd parity is overlapping the ground configuration. The unclassified reversed lines were searched for any repeated intervals of significance, yielding four new levels. Upper and lower levels were then successively generated using the entire wave number catalog of about 8000 lines. Data on the most reliable lower levels are tabulated. About 150 even upper levels were found, but only one even level was found lying below the new system. It is suspected that this is the ground term, $^3H_6$, of $4f^{12}6s^2$. (P.C.H.)

25166 NEW ODD LEVELS OF NEUTRAL ERBIUM (Er I). Nissan Spector (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Am., 55: 576-7(May 1965).

Approximately 1200 lines of erbium in absorption were observed in the region between 2700-4700 Å by means of a King furnace. By differing the absorption lines and using wavelengths previously determined, 20 levels were found that were assigned to $4f^{11}5d6s^2$. These include the complete group of 10 levels obtained by adding, in J_{1-j} coupling, a 5d electron to the $^4I_{15/2}$ level of the $4f^{11}$ core. These 10 levels have J values ranging from 5 to 10. They account for 103 additional self-reversed lines. Thus, together with those classified by $4f^{12}6s^2$ levels, more than half of the observed

self-reversed lines are now classified. Data are tabulated. (P.C.H.)

25167 COHERENT BREMSSTRAHLUNG FROM Si SINGLE CRYSTAL. I. EXPERIMENT. Sadayuki Kato, Tadashi Kifune, Yoshitaka Kimura, Masaaki Kobayashi, Kunitaka Kondo, Tetsuji Nishikawa, Hiroshi Sasaki, Kunio Takamatsu, Seishi Kikuta, and Kazutake Kohra (Tokyo Univ.). J. Phys. Soc. Japan, 20: 303-7(Mar. 1965).

The interference effects in the production of bremsstrahlung in a silicon single crystal were studied by using 720-Mev electrons. The energy spectrum of the bremsstrahlung exhibited interference maxima of the first five orders. The intensity variation of the 150-Mev photons with the rotation of the crystal showed also three interference maxima on each side of the central minimum. The observed interference conditions for the photon energy and angles of incidence of electrons relative to crystal axes agree with the theory. (auth)

25168 WAVE FUNCTIONS AND OSCILLATOR STRENGTHS OF Be-LIKE IONS (Be I, C III, N IV, O V). H. Pfennig, R. Steele, and E. Trefftz (Max-Planck-Institut fur Physik and Astrophysik, Munich). J. Quant. Spectry. Radiative Transfer, 5: 335-57(Mar.-Apr. 1965).

Several excited states of Be-like ions (Be I, C III, N IV, O V) are calculated by the Roothaan version of the Hartree–Fock method, namely $2s^2\ ^1S$, $2s\,2p\ ^{1,3}P$, $2s\,3s\ ^3S$, $2s\,3p\ ^{1,3}P$, $2s\,3d\ ^{1,3}D$, $2p^2\ ^3P$. Eigenvalues and energies are given. The wave functions are given as sums over exponentials multiplied by a suitable power of r (Slater-type wave functions). Orthogonality integrals are also tabulated. Oscillator strengths are calculated with dipole length and dipole velocity formula, with experimental and with theoretical energy differences. For triplet transitions the results seem fairly reliable, while for singlet transitions there are large deviations between the f-values calculated by dipole length and dipole velocity formula. Configuration mixing should be taken into account in these cases. The f-values calculated with wave functions of different degree of accuracy show that the discrepancy between dipole length and dipole velocity values is insensitive towards the quality of the Hartree–Fock wave functions. The calculated line strengths are compared with the values of Kelly. Satisfactory agreement is noted. (auth)

25169 USE OF EXPERIMENTAL DATA ON THE INFRARED BAND INTENSITIES OF ISOTOPIC MOLECULES IN SOLVING THE INVERSE ELECTRO-OPTICAL PROBLEM. L. M. Sverdlov. Opt. Spectry. (USSR) (English Transl.), 18: 13-15(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 27-32(Jan. 1965).

The question of the possibility of using experimental data on the infrared band intensities of isotopic dipole-containing molecules in solving the inverse electro-optical problem was investigated. It is shown that the number of linearly independent electro-optical parameters will equal the number of normal vibrations of the initial high-symmetry molecule which are active in the infrared spectrum, and experimental data on the infrared band intensities of the isotopic molecules give no additional equations for determining a larger number of electro-optical parameters. These data are helpful only in the choice of the correct signs for $\partial p/\partial q_i$ from the various possible combinations, as in the case of molecules without dipoles. (auth)

25170 THE RELATIONSHIP BETWEEN THE THERMOSTIMULATED ELECTRON EMISSION, CONDUCTION, AND LUMINESCENCE OF ALKALI HALIDE CRYSTALLOPHOSPHORS. P. A. Pipinis and B. P. Grigas. Opt. Spectry. (USSR) (English Transl.), 18: 43-6(Jan. 1965). Translated from Optika i Spectroskopiya, 18: 85-91(Jan. 1965).

The thermoluminescence and electrical conductivity of the crystallophosphors NaCl–Ag and NaCl–Ni, excited by x rays, are investigated. A comparison of these results with the results of an investigation of the thermostimulated electron emission in parallel with the thermoluminescence of these same crystallophosphors shows that the maxima in the conductivity and electron emission are explained by the liberation of electrons from the same trapping levels. (auth)

25171 DETERMINATION OF THE EFFECTIVE CROSS SECTION OF COLLISIONS OF THE SECOND KIND BETWEEN METASTABLE NEON ATOMS AND HYDROGEN MOLECULES. K. S. Mustafin and N. M. Khashimov. Opt. Spectry. (USSR) (English Transl.), 18: 74-5(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 141-3(Jan. 1965).

The I_α/I_β and I_β/I_γ ratios (intensities of H_α, H_β, and H_γ lines) were measured in the high-frequency discharge of He + H_2 and Ne + H_2 mixtures at 50 and 0.2 MHz. The increases in the I_α/I_β ratios for the Ne + H_2 mixtures and their further intensification by changing from 50 to 0.2 MHz show that the dissociative reaction $Ne(3s\ ^3P_2) + H_2 \rightarrow Ne(^1S_0) + H^* + H + 0.05$ ev occurs. The excited atom concentration was determined by the reabsorption method, and the effective cross section was estimated to be 2.4×10^{-16} cm^2. (D.L.C.)

25172 SENSITIZING OF THE LUMINESCENCE OF TRIVALENT YTTERBIUM BY NEODYMIUM IN SILICATE GLASSES. V. P. Kovalev and G. O. Karapetyan. Opt. Spectry. (USSR) (English Transl.), 18: 102-3(Jan. 1965). Translated from Optika i Spektroskopiya, 18: 182-4(Jan. 1965).

An investigation was made of the mechanism of the transfer of excitation energy from Nd^{3+} to Yb^{3+}. The spectra and luminescence kinetics of donor Nd^{3+} and acceptor Yb^{3+} were studied in silicate glasses containing 2 and 5.5% Nd_2O_3 and 0 to 8% Yb_2O_3. The results indicate a concentration quenching of the Nd radiation and a nonradiative energy transfer to Yb^{3+} by inductive interaction. The transfer probability is calculated and found to become equal to the luminescence probability when the Yb_2O_3 content is 2 to 2.5%. (D.L.C.)

25173 MEASUREMENTS OF TRANSITION PROBABILITIES OF 2S-2P^0 TRANSITIONS IN LITHIUM-LIKE IONS. K. Berkner, W. S. Cooper, III, S. N. Kaplan, and R. V. Pyle (Univ. of California, Berkeley). Phys. Letters, 16: 35-6 (May 1, 1965). (UCRL-11953(Rev.))

The foil-excitation technique was used to measure directly the average of the lifetimes of the $1s^22p(^2P^0\ 1/2)$ and $1s^22p(^2P^0\ 3/2)$ states of C IV, N V, O VI, and Ne VIII ions in the lithium-like isoelectronic sequence. Ion beams were accelerated to an energy of 0.97 Mev/nucleon by the Berkeley Hilac, and were further ionized and excited in an aluminum foil. The decay of radiation from the ^2S-$^2P^0$ transitions was measured as a function of foil position; a vacuum-uv monochromator with a sodium-salicylate-covered photomultiplier was used as a photon detector. The transition probabilities obtained by a least-squares fitting of the data to an exponential plus a constant background are tabulated along with theoretical calculations by the Hartree-Fock method and the 45-term configuration interaction wave functions. (L.B.S.)

25174 ELECTRONIC EQUILIBRIUM AND TRANSITION STAGES. J. Dutreix, A. Dutreix, and M. Tubiana (Institut Gustav Roussy, Villejuif, France). Phys. Med. Biol., 10: 177-90(1965).

The concept of electronic equilibrium is presented in its general aspects. Absolute equilibrium requires conditions that are not fulfilled for high-energy photon beams, but a transient equilibrium can be considered. The influence function is used to introduce the concept of a practical equilibrium. Transition stages at a plane interface perpendicular to the beam direction are dealt with by a simplified form of the influence function, reduced to one parameter. Some particular conditions are considered for which experimental data are available, e.g. interface between vacuum and medium, interface between low-density and high-density media, and the interface between media of different atomic composition. (auth)

25175 ON SPUTTERING. Kiyoichi Takatsu. Terebijon, 17: 428-34(1963). (In Japanese)

Descriptions are given on the following subjects: the earlier evaporation theory, the paradoxes between this theory and experimental results, the theory based on collision of ions with lattice atoms, its deficiency in explaining the measured results of minimum energy of the ions, and the sputtering efficiency of low-energy and high-energy ions and for various substances. Sputtering in glow discharges was studied and a rule of W (amount of sputtering) $\propto I^3$ (current) is derived. 23 Ref. (auth)

25176 NUCLEAR RELAXATION IN LOW FIELDS AND THE STUDY OF ULTRASLOW ATOMIC MOTIONS IN SOLIDS. David Charles Ailion. Thesis, Urbana, Ill., Univ. of Illinois, 1964. 134p.

A new magnetic resonance technique for observing atomic motion is developed and applied to the observation of translational diffusion in lithium metal. By this technique the temperature range over which diffusion can be observed by magnetic resonance is greatly increased. In lithium metal the new technique enables τ, the mean jump time, to be observed over nine decades, from $\tau = 10^{-9}$ sec to $\tau = 1$ second. The technique is based upon the realization that the process of atomic jumping results in a loss of dipolar order and is thus a thermodynamically irreversible process. In order actually to observe the loss of dipolar order, it was found to be experimentally feasible to demagnetize the system adiabatically, thereby transferring order from the Zeeman system to the dipolar system. In the demagnetized state the order consists of alignment of the nuclei along their local fields; thus order is lost when the nuclei jump to different lattice sites. After the jump, cross-relaxation between the dipolar and Zeeman systems transforms the loss of dipolar order to a loss of Zeeman order which is experimentally observed as a decrease in the magnetization. A new theory, based on the concept of spin temperature, is developed in order to understand the data. The validity of the new theory is demonstrated both theoretically and experimentally. The nuclear relaxation is observed in a frame rotating at a frequency such as to exactly cancel the static magnetic field. The theory of relaxation in weak fields both in the laboratory frame and in the rotating frame is discussed in detail, and a description of the experimental techniques and the experimental results is presented. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25177 SURFACE IONIZATION OF SPUTTERED ATOMS. Juergen Max Schroeer. Thesis, Ithaca, N. Y., Cornell Univ., 1964. 106p.

The surface ionization of molybdenum atoms sputtered from polycrystalline molybdenum by argon ions in the energy range from 100 to 900 ev was investigated. An ultrahigh vacuum glass mass spectrometer with an electron multiplier as detector was used. The ratio R of ionized to neutral sputtered atoms was measured as a function of the target temperature in the range 300 to 1800°K, of the coverage by adsorbed gases, and of the energy of the sputtered atoms. Two approaches to understanding the mechanism by which sputtered atoms become ionized are proposed and examined by comparison with experiment. The first approach is based on a calculation of a quantum-mechanical transition probability, using the adiabatic approximation. The matrix element describing the interaction cannot be easily calculated. Two reasonable estimates were made, however, which made it possible to obtain two analytical expressions for R. The second approach is based on the assumption of thermal equilibrium of the electrons in the vicinity of the sputtered atom. The validity of this assumption is discussed. This assumption leads to a modified Langmuir-Saha equation. The validity of these expressions for R was tested by measuring R as a function of the target temperature T and of the coverage θ_a by CO, H, and O. (A.G.W.)

25178 A STUDY OF CERTAIN INELASTIC ELECTRON-ATOM COLLISION PROCESSES. Neal Francis Lane. Thesis, Norman, Okla., Univ. of Oklahoma, 1964. 242p.

A method was devised to calculate the cross sections of inelastic electron-atom collisions under near-resonance conditions. This method (referred to as the method of resonance distortion) consists of solving the limiting exact-resonance problem as the zeroth-order approximation and using this solution to obtain the first-order solution by an interaction procedure. Application of this method was made to a schematic model with an isotropic inverse-square interaction potential and to the problem of electron-atom collisions with ns → np transition. The total cross sections for the 3s → 3p transition in Na were calculated by the resonance-distortion method for various incident electron energies, and the results show better agreement with experiment than do those of the Born Approximation and of Seaton's version of the modified Born Approximation. The relative contributions of several radiative processes to the hydrogen continuum in the range of wavelengths from 2000 to 6000 A° were investigated for a range of electron temperatures and several different ion concentrations. Cross sections for the $6^3P_1 \rightarrow 6^3P_2$ transition in Hg were calculated under the assumption of exact resonance. The appropriate matrix elements were calculated, employing atomic wave functions based on the original SCF results of Hartree. The angular dependence was removed from the matrix elements by an averaging procedure, and the resulting two-channel problem solved numerically. The total cross sections are found to have the proper energy dependence, within the limits of the experimental determination. (A.G.W.)

25179 ELECTRON CAPTURE FROM ATOMIC HYDROGEN. James Joseph Grant, Jr. Thesis, Fordham, N. Y., Fordham Univ., 1964. 136p.

The differential and total cross sections for the resonance charge transfer reaction $H^+ + H(1s) \rightarrow H(1s) + H^+$ are calculated in a distorted wave approximation retaining terms of third order in the interaction potentials. It is found that, for energies above 10 kev, the only significant third order term arises from the incident proton-electron interaction, the proton-proton term being smaller by a factor equal to the electron-proton mass ratio. In the infinite energy limit the third order contributions vanish as $E^{-\frac{1}{2}}$ relative to the first Born terms, while at moderate energies (10 to 500 kev), they result in an increase of about 40% in the calculated cross sections. The probability of capture into excited states of the hydrogen atom is investigated. The analysis yields a correction factor that, combined with the cross sections for 1s – 1s transitions, yields an estimate of the cross sections for capture into all final states. These results are compared with the existing experimental data and a generally good agreement is obtained. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25180 EXCITATION OF HELIUM ATOMS BY ELECTRON IMPACT. Frank Lee Miller. Thesis, Norman, Okla., Univ. of Oklahoma, 1964. 111p.

The absolute apparent electron excitation functions of helium were measured for the 3^1S, 4^1S, 5^1S, 6^1S, 3^1P, 4^1P, 3^1D, 4^1D, 5^1D, 6^1D, 3^3S, 4^3S, 5^3S, 3^3P, 3^3D, 4^3D, 5^3D, and 6^3D states at pressures sufficiently low that the effects of radiation imprisonment and collisional excitation transfer can be neglected. Corrections due to polarization of the radiation and the cascading from the upper excited states were applied to the experimental data and the true excitation functions obtained. The peak values and the shape of these excitation functions are compared with results reported from other laboratories. Generally good agreement is found where the collisional excitation transfer was properly reduced and allowance was made for the cascading effect. The experimental cross sections show satisfactory agreement with the theoretical values calculated by the Born Approximation for the ^1S and ^1P states at high electron energies, but are about four times larger than the theoretical values for ^1D states. In the case of the triplet series the experimental cross sections exceed the calculated values by factors of ten to one hundred or more. It is concluded that the population of the triplet states is produced mainly by processes other than direct excitation. An

investigation of the 3^3D apparent excitation function from zero to five hundred volts at relatively high pressure provides excellent confirmation of the St. John, Fowler theory of transfer of excitation energy. The theory, however, does not account for unusual characteristics of the high-pressure 3^3P apparent excitation function. These characteristics appear to be due to a departure from the monoenergetic nature of the electron beam used rather than inherent changes in the apparent excitation function at these pressures. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25181 EXCITATION OF THE 2^1S AND 2^3P STATES OF HELIUM BY ELECTRON BOMBARDMENT. Helen K. Holt and Robert V. Krotkov. 9p. (CONF-758-9)

From American Physical Society Meeting, New York, Jan. 1965.

An experiment was performed to measure the cross sections for producing excited states of helium by electron bombardment. A schematic diagram of the apparatus consisting of a beam machine with three separately pumped chambers is shown. The total metastable cross sections, the 2^1S and 2^3P cross sections and the cross sections for populating the three magnetic substates of the 2^3S level, both directly and by decay from the 2^3P state, were measured. The relative populations of the magnetic substates of the indirectly made 2^3S atoms are a measure of the populations of the J, M_J sublevels of the 2^3P state. (L.B.S.)

25182 PRODUCTION OF HIGHLY EXCITED NEUTRAL ATOM FOR INJECTION INTO PLASMA DEVICES. S. T. Butler and R. M. May (Univ. of Sydney). 27p. (CONF-641108-20)

From American Physical Society, New York.

The production of highly excited states of atomic hydrogen by charge exchange reactions is considered, discussing first the reaction $H^+ + H(1s) \rightarrow H(excited) + H^+$. The results for this reaction are used as a basis with which to compare excited state production of hydrogen atoms by charge exchange in gases other than atomic hydrogen. The results are expressed in terms of the equilibrium ratio i_n/i_c, the ratio of the flux of excited states with principal quantum number n to the (constant) flux of protons incident on the neutralizer. It is found that with atomic hydrogen as neutralizer the ratio i_n/i_c has a maximum of about $0.75/n^3$ at 20 kev. For alkali atoms such as Li and Na the maximum value of i_n/i_c occurs at about 10 kev being of similar magnitude to, but probably smaller than, the value for atomic hydrogen. In the case of the inert gases He, Ne and Ar, the maximum value of i_n/i_c occurs in the vicinity of 50 to 70 kev and again is of similar magnitude to, but probably slightly larger than, the maximum value for atomic hydrogen. The inert gases thus offer a number of advantages over alkali gases as neutralizers: they probably yield as large if not larger values of i_n/i_c at maximum; the maximum occurs at higher energies, so that the natural decay lengths of the excited atoms are correspondingly longer. They may be very much more easily handled experimentally. (auth)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

25183 ENERGY SPECTRA OF ELECTRONS FROM π-μ-e DECAYS IN INTERSTELLAR SPACE. Joseph H. Scanlon (Grumman Aircraft Research Dept., New York and St. John's Univ., Jamaica, N. Y.) and S. N. Milford. Astrophys. J., 141: 718-29(Feb. 15, 1965).

Expressions are derived in closed form for the electron energy spectra from π-μ-e decay in space. The known asymmetric distribution of electrons from muon decay in the muon rest frame is Lorentz-transformed to the pion rest system, where a summation over the muon distribution is effected. After a relativistic transformation to the laboratory system, the electron angular dependence is integrated out, giving the energy distribution. Values of the electron energy spectrum are computed for pion kinetic energies between 3 Mev and 112 Bev. The maximum of the distribution is found to decrease monotonically with increasing pion energy. The effect of the initial anisotropy is determined; it is seen to raise the level of the distribution maximum and to reduce the contributions for higher-energy electrons. (auth)

25184 NUCLEAR INTERACTIONS OF COSMIC RAYS AS THE SOURCE OF THE SYNCHROTRON RADIATING PARTICLES OF OUR GALAXY. J. B. Pollack (Harvard Univ., Cambridge, Mass.) and G. G. Fazio. Astrophys. J., 141: 730-44(Feb. 15, 1965).

A detailed analysis of the production of secondary electrons and positrons in the galactic disk by cosmic radiation is presented. The calculations employ data from high-energy nuclear physics experiments. The object of this analysis is to determine how well these particles can explain the spectrum and intensity of the meter-wavelength radio noise from the halo and disk of the Galaxy. The calculated spectrum and intensity do not agree exactly with the measured values, but are very useful in trying to understand the existing situation with respect to high-energy particles in the Galaxy. Independent of the origin of the synchrotron-radiating particles, the complete diffusion of relativistic cosmic electrons and positrons throughout the Galaxy is demonstrated, and information on the magnetic-field intensity in the disk and halo is obtained. Methods by which the secondary origin of the synchrotron radiating particles can be tested are examined, and in particular the positron-to-electron ratio in cosmic rays is predicted as a function of energy. (auth)

25185 ENERGY SPECTRUM OF GALACTIC COSMIC RAYS (COMPUTED). A. N. Charakhch'yan and T. N. Charakhch'yan (Lebedev Inst. of Physics, Moscow and Moscow State Univ.). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 509-16(1964).

On the basis of a number of experimental results obtained from a study of solar cosmic rays—data on the form of the energy spectrum, diffuse propagation of particles in interplanetary space, and the explosive nature of the generation process—the energy spectrum of galactic cosmic rays at the earth was calculated in agreement with experimental data. It follows from the results of this theory that cosmic rays were generated at the time of a gigantic explosion which occurred 10^8 to 10^9 years ago in the neighborhood of the galactic center. The energy of the cosmic rays released in this explosion was about 5×10^{56} ergs. (auth)

25186 TEMPERATURE EFFECT OF THE COSMIC-RAY NEUTRON COMPONENT. N. S. Kaminer, S. F. Ilgach, and T. S. Khadakhanova (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 516-19(1964).

A method is proposed which makes it possible to investigate the temperature effect of the cosmic-ray neutron component even when there are variations of the primary component with a large amplitude. The variations of the primary component are excluded by subtraction of the data for one station from the data for another station, the two stations having similar geomagnetic cutoff rigidities and being situated in different hemispheres. This study is based on data for Hobart and Chicago. Investigation of the differences of the mean monthly values of intensity of these stations made it possible to detect a seasonal wave caused by seasonal changes of atmospheric temperature. The temperature effect discovered is found from data for 1960–1962. Its amplitude attains 1.2 to 1.6% and exceeds by a factor of approximately 2 the amplitude of the theoretically expected effect. There is a brief discussion of the possible causes of the difference between the experimental and theoretical results. (auth)

25187 OBSERVATION OF X-RAY SOURCES OUTSIDE THE SOLAR SYSTEM. Riccardo Giacconi and Herbert

Gursky (American Science and Engineering, Inc., Cambridge, Mass.). Space Sci. Rev., 4: 151-75(Mar. 1965).

A brief review of experimental observations on x-ray sources outside the solar system and of the mechanisms proposed for the production of the observed radiation is presented. Some recent advances in instrumentation are also described. 53 references. (D.C.W.)

25188 COSMIC RAY MUON POLARIZATION. Merwyn Ray Vander Lind. Thesis, Athens, Ohio, Ohio Univ., 1964. 44p.

Since the cosmic-ray pion energy distribution function is known to decrease with increasing energy, a transformation of a given muon energy to the laboratory coordinate system does not destroy the muon polarization completely. Results of an experiment to measure the longitudinal partial polarization of positive muons at ground level are reported. A coincidence-anticoincidence counter array promptly pulsed a spark chamber through which 0.3-Bev muons passed in order to establish the momentum direction of each muon. The absence of an anticoincidence count indicated that a muon stopped in a second spark chamber, containing aluminum plates, which was pulsed a few muon mean lifetimes later. The "up-down" decay asymmetry was measured using 90° stereo photography. The polarization was found to be 0.31 ± .12, where no correction has been made for the approximate 5 per cent depolarization that occurs in the atmosphere and moderator. This value of polarization is consistent with the assumption that 0.3-Bev muons are entirely of pion parentage. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25189 COSMIC RADIATION AND HIGH ENERGY INTERACTIONS. V. D. Hopper. Scientific Monographs on Physics. London, Logos Press and Englewood Cliffs, N. J., Prentice-Hall, Inc., 1964. 240p.

A survey on investigations of the origin, spectra, interactions and variations of cosmic radiation is presented, covering experimental results and techniques, magnetic field effects, laboratory studies of high-energy interactions, and associated theory. 200 references. (D.C.W.)

25190 INTERNATIONAL CONFERENCE ON COSMIC RAYS, JAIPUR, DECEMBER 2-14, 1963, PROCEEDINGS. VOLUME 2. MODULATION. Under the Auspices of The International Union of Pure and Applied Physics and The Department of Atomic Energy, Government of India. R. R. Daniel, P. J. Lavakare, M. G. K. Menon, S. Naranan, N. W. Nerurkar, Yash Pal, and B. V. Sreekantan, eds. Bombay, The Commercial Printing Press Limited, 1964. 484p. Available from Tata Inst. of Fundamental Research, Bombay.

Sixty papers are included. Separate abstracts are prepared for 54 papers. Two papers were previously abstracted for NSA; see abstracts 17: 34699 and 18: 22699. (M.J.T.)

For abstracts of individual papers see: 25191, 25192, 25193, 25194, 25195, 25196, 25197, 25198, 25199, 25200, 25201, 25202, 25203, 25204, 25205, 25206, 25207, 25208, 25209, 25210, 25211, 25212, 25213, 25214, 25215, 25216, 25217, 25218, 25219, 25220, 25221, 25222, 25223, 25224, 25225, 25226, 25227, 25228, 25229, 25230, 25231, 25232, 25233, 25234, 25235, 25236, 25237, 25238, 25239, 25240, 25241, 25242, 25243, and 25435.

25191 DIRECTIONAL INTENSITIES OF PRIMARY COSMIC RAYS NEAR THE EQUATOR. B. Dayton and P. K. Kunte (Tata Inst. of Fundamental Research, Bombay). p.9-15 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Directional intensities of primary cosmic rays were measured with scintillator-Cherenkov telescopes in balloon flights; in two flights the vertical intensity was measured, while in the two others the telescope was inclined 45° to the zenith and directed toward the east and west alternately. Results are presented for primary fluxes of protons and alpha particles. East-west asymmetry factors computed from the data are compared with directly observed values. (M.J.T.)

25192 ORIENTATION MECHANISM FOR HIGH ALTITUDE COSMIC RAY RESEARCH. B. Dayton and P. K. Kunte (Tata Inst. of Fundamental Research, Bombay). p.16-19 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A system for maintaining the orientation of cosmic-ray instruments for measuring directional asymmetries in balloon flights was developed. The direction-sensor fluxgate magnetometer, the servomechanism driving a d-c motor with signals from the magnetometer, and the general structure of the device are described. Successful experiments using counter telescopes and emulsion stacks oriented by this system are mentioned. (M.J.T.)

25193 NEUTRON ALBEDO MEASUREMENTS ON POLAR-ORBITING SATELLITES. J. A. Lockwood and J. H. Trainor (Univ. of New Hampshire, Durham). p.20-5 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Integrated neutron flux to 10 Mev was measured on three polar-orbiting Agena satellites. The detection system, consisting of a BF_3 proportional counter in anticoincidence with a surrounding ring of charge-particle proportional counters, is described, and its response is shown. Counting rates from the three flights corrected to 300 km altitude are given as a function of geomagnetic latitude. (M.J.T.)

25194 NEUTRON ALBEDO FLUX AT 45° GEOMAGNETIC LATITUDE. G. Boella (Universita, Milan and Instituto Nazionale di Fisica Nucleare, Milan), G. Degli Antoni, C. Dilworth, M. Panetti, L. Scarsi, and D. Shapiro. p.26-30 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The flux of neutrons to 20 Mev was measured to 4 gm/cm^2 residual atmosphere in three balloon flights at 45° geomagnetic latitude, using boron-plastic scintillators with various thicknesses of polyethylene moderator. Discrimination against gamma rays and charged particles was accomplished by the use of two different enrichments of ^{10}B in the scintillator. The neutron flux is given as a function of atmospheric depth and extrapolated to the top of the atmosphere to obtain a value for the neutron albedo flux. (M.J.T.)

25195 DEVELOPMENT OF THE COSMIC RAY STORMS. S. Mori (Nagoya Univ., Japan), H. Ueno, S. Sagisaka, K. Nagashima, and Y. Sekido. p.33-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on cosmic-ray intensity from 13 stations at 40 to 60°N geomagnetic latitude for July 1957 to Dec. 1958 were analyzed using a spherical-harmonic equation to separate cosmic-ray intensity into worldwide-variation (Dst) and diurnal-variation (DS) terms. The DS vectors are presented and correlated with occurrences of type-IV radio bursts and SSC geomagnetic storms; relations between the DS phase and the solar bursts are discussed. The east-west asymmetry of the average DS phase is examined using the superposed epoch method. (M.J.T.)

25196 A NEUTRON INTENSITY INCREASE OBSERVED AT HIGH ALTITUDE IN ASSOCIATION WITH AN AURORAL ZONE X-RAY EVENT. N. R. Parsons, J. G. Greenhill, K. B. Fenton, and A. G. Fenton (Univ. of Tasmania, Hobart, Australia). p.38-42 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Neutron and x radiation were observed in a balloon flight at Macquarie Island, using a ^{10}B-enriched BF_3 proportional counter and a NaI scintillator. Results are presented and correlated with riometer absorption measurements and neutron and x-ray levels for a flight when no neutron events were observed. Preliminary interpretations of the neutron increase are made. (M.J.T.)

25197 COSMIC RAY EFFECTS DURING MAGNETIC STORMS. M. V. Alania, G. M. Blokh, Y. L. Blokh, et al. p.48-69 of "International Conference on Cosmic Rays.

Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Six papers are included on effects of geomagnetic storms on cosmic radiation. Results of calculations of cosmic-ray spectral variations using the dynamical model of the Forbush effect are presented. Numerical calculations are reported of the influence of the filiform current equatorial ring on the geomagnetic cutoff rigidity of directional cosmic radiation. The effect of the spherical distribution of the west current on the geomagnetic cutoff rigidity is considered. Data on anomalies in the cosmic-ray intensity during magnetic storms are reviewed. Data on cosmic-ray effects during magnetic storms in August 1958, from four stations are studied. Correlations of solar activity, magnetic disturbances, auroras, cosmic-ray variations, ionospheric disturbances, and earth current are examined for Aug.-Sept. 1959. (M.J.T.)

25198 COSMIC RAY VARIATIONS. L. I. Dorman. p.73-116 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Results on research in cosmic-ray variations are reviewed. The use of cosmic-ray variations as a method of outer space exploration is discussed. Mechanisms of cosmic-ray variations are classified and discussed, considering atmospheric-origin, geomagnetic-origin, and solar-activity-origin (11-yr) variations. Density gradients in interplanetary space and the diurnal variation are considered. The dynamic model of the Forbush effect is described, and features distinguishing solar from galactic rays are reviewed. (M.J.T.)

25199 MODULATION OF GALACTIC COSMIC RAYS IN THE SOLAR SYSTEM. Vikram A. Sarabhai (Physical Research Lab., Ahmedabad, India). p.117-36 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A survey is presented of results of research on the spectrum and intensity of heavy primaries measured in balloons and satellites and on cosmic-ray intensity measured in space probes; on the diurnal variation of cosmic-ray anisotropy; on the use of quantitative methods in studying the anisotropy; and on the daily variation of meson intensity. Implications of the sun's rotation and the nonuniformity of the solar-wind velocity for the plasma and magnetic fields in interplanetary space are considered. (M.J.T.)

25200 TIME VARIATION OF THE PRIMARY ENERGY SPECTRUM. H. V. Neher (California Inst. of Tech., Pasadena). p.139-54 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The history of the discovery of time variations in cosmic radiation is reviewed. Present knowledge of the Forbush and 11-year variations is discussed, and examples of data are given showing daily and yearly variations in ionization from primaries and yearly absorption for various depths of atmosphere. (M.J.T.)

25201 THE PRIMARY COSMIC RAY SPECTRUM AND THE TRANSITION REGION BETWEEN INTERPLANETARY AND INTERSTELLAR SPACE. J. A. Simpson (Univ. of Chicago). p.155-69 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data are discussed showing that the relation between solar activity and the primary cosmic-ray intensity is not a simple lag over the solar cycle and that the characteristic decay time of the magnetic modulating region with decline of the solar cycle is much greater than for its build-up with the beginning of the solar cycle. Correlations between neutron intensity produced by primary particles and solar activity as indicated by sunspot number are examined for 1952 to 1963. Galactic cosmic-ray spectral changes brought about by the magnetic modulating region are discussed. (M.J.T.)

25202 COSMIC RAY WORK AT IMPERIAL COLLEGE IN RELATION TO SOLAR MODULATION AND GEOMAGNETIC EFFECTS. H. Elliot. p.170-81 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The primary cosmic-ray rigidity spectrum was measured, using a Cherenkov counter on the US/UK satellite, Ariel I; the rigidity dependence of the modulation process is deduced from the data and compared with that calculated using Parker's solar wind model. Results of aircraft latitude surveys, using a scintillator telescope, are presented. Investigations on geomagnetic thresholds using a terrella are described; effects of superposition of various external field configurations on that of the terrella dipole and the dependence of penumbral transparency on altitude were studied. An experiment measuring solar daily variation at a depth of 65 m water equivalent, using muon scintillation telescopes, is described. (M.J.T.)

25203 INTENSITY VARIATIONS AND EFFECTIVE PRIMARY SPECTRUM FOR MESONS OBSERVED AT APPROXIMATELY 40 M.W.E. UNDERGROUND AT HOBART. A. G. Fenton (Univ. of Tasmania, Hobart, Australia). p.185-90 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A calculation was made leading to the effective primary spectrum producing mesons able to reach 40 mwe below ground level. The pion energy distribution predicted by the Fermi statistical model for nucleon-nucleon interactions in the extreme relativistic case was used. It is found that primary protons with energy as low as 50 Bev have a significant effect at depths of 40 mwe; this is important in studying energy dependence of modulation phenomena such as Forbush decreases. Sample data from the Hobart stations are shown to illustrate the variability in the observed response of various detectors to different events. (M.J.T.)

25204 COSMIC RAY RESEARCH AT HOBART (GROUP ACCOUNT). A. G. Fenton (Univ. of Tasmania, Hobart, Australia). p.191-8 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A description is given of the six ground observation stations and four balloon launching sites and of the rigidity cutoffs and equipment used. The program of continuous observations is described, including studies on the energy dependence of modulation processes and directional anisotropies, on the effect of wind velocity on barometric data, on the rigidity dependence of solar flare increases, and on the sidereal daily variation. High-altitude experiments on counting rate vs atmospheric depth, on east-west asymmetry, on neutron enhancements produced by low-energy protons, and on effects of high-altitude nuclear explosions are reviewed. (M.J.T.)

25205 GROUP ACCOUNT (JAPANESE WORKS ON COSMIC-RAY INTENSITY MODULATION). Y. Sekido (Nagoya Univ., Japan). p.199-218 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Work on cosmic-ray modulation is mentioned, including research on threshold rigidities, diurnal variation and sunspot number, rigidity spectrum and the solar cycle, and the energy spectrum of the Forbush decrease. Two projects are discussed in detail, in which the time variation of the cosmic ray anisotropy due to interplanetary modulation was obtained using spherical harmonic analysis of the IGY-network data. The time variation of the anisotropy during a cosmic-ray storm was studied to find the anisotropy distribution inside the solar magnetic cloud; a plasma-shell model of the cloud is presented. The time variation of the anisotropy also was studied during the solar rotation to find anisotropies at various heliographic longitudes. It was found that the frequency of occurrence of the diurnal variation with inverse phase showed a 27-day periodic variation; the results were used to obtain a picture of interplanetary space and the solar-wind system. (M.J.T.)

25206 SUMMARY OF THE WORK DONE BY THE FOLLOWING STAFF OF LABORATORIO DE RADIATION

COSMICA, UNIVERSIDAD DE BUENOS AIRES, COMISION NACIONAL DE ENERGIA ATOMICA, ARGENTINA. N. Becerra, J. M. Cardoso, H. S. Ghielmetti, A. Godel, H. Heredia, L. C. Marzulli, and J. G. Roederer. p.219-24 of "International Conference on Cosmic Rays. Vol 2." Bombay, Tata Inst. of Fundamental Research, 1964.

High-altitude balloon measurements are reviewed, with descriptions of the G-M and scintillation detectors and telemetry systems used; counting rate vs atmospheric depth curves were obtained and fitted by an empirical function; low-energy electron-photon cascades were also studied. Operation of ground neutron monitors and meson telescopes is mentioned. The processes of high-energy solar-particle acceleration and propagation were analyzed. Analyses are in progress of cosmic-ray storms and the time-variation of anisotropy. (M.J.T.)

25207 SECULAR TREND OF COSMIC-RAY INTENSITY IN THE STRATOSPHERE AND PRIMARY COSMIC-RAY ENERGY SPECTRUM. A. N. Charakhchyan and T. N. Charakhchyan (Lebedev Inst. of Physics, Moscow and Moscow State Univ.). p.227-33 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Results of measurements of cosmic-ray intensity at 64, 51, and 41°N geomagnetic latitude for 1957 to 1962, using radiosondes, are presented. The measured secular trend correlated well with the 11-year solar-activity cycle, indicated by sunspot numbers. The particle intensity in the upper atmosphere as a function of altitude is studied to obtain information on the variation of the primary energy spectrum with solar activity. Corrections subtracting the solar component from intensity near the top of the atmosphere are given. (M.J.T.)

25208 MEASUREMENT OF PRIMARY COSMIC RAY CHARGE AND ENERGY SPECTRA DURING 1963. V. K. Balasubrahmanyan and F. B. McDonald (Goddard Space Flight Center, Greenbelt, Md.). p.234-9 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Differential energy spectra of H and He nuclei at 100 to 800 Mev/nucleus, integral H and He flux over 800 Mev/nucleus, and cosmic-ray charge spectra from Z = 1 to 8 were measured using a scintillation- and Cherenkov-counter telescope on a balloon flight from Fort Churchill, Canada. The ratio (Li + Be + B)/(C + N + O) appears constant in the two regions 400 to 800 and > 800 Mev/nucleus; the ratio extrapolated to the top of the atmosphere is 0.28 ± 0.08. A marked difference is observed in the form of the low-rigidity differential spectra of H and He. Results are compared with those from the previous solar cycle. (auth)

25209 MODULATION OF LOW ENERGY GALACTIC COSMIC RAYS. C. E. Fichtel, D. E. Guss, D. A. Kniffen, and K. A. Neelakantan (Goddard Space Flight Center, Greenbelt, Md.). p.240-5 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Results are presented of nuclear-emulsion measurements of fluxes of cosmic H and He nuclei, obtained in balloon flights from Fort Churchill, Canada, in 1961 and 1962. Results are compared with previous data for 1961 in order to examine the variation with solar activity. Combined results indicate the presence of a splitting of the differential rigidity spectrum of protons and a multiple of that of the He nuclei below about 1.3 Bv. (M.J.T.)

25210 THE MODULATION OF HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Phyllis S. Freier and C. J. Weddington (Univ. of Minnesota, Minneapolis). p.246-9 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Variations in intensity of primary cosmic nuclei with $Z \geq 3$ were studied using balloon exposures of nuclear emulsions and Cherenkov scintillators. Intensities were measured during Forbush decreases and compared with intensities of $Z \geq 3$ nuclei and alpha particles measured at other times. Regression curves between these intensities and sea-level cosmic-ray intensity recorded by neutron monitors were obtained by analysis in correlation with previous data. (M.J.T.)

25211 THE INTENSITY OF COSMIC RAY ALPHA-PARTICLES AT ABSOLUTE SOLAR MAXIMUM. P. S. Freier, G. Greer, J. Valdez, and C. J. Weddington (Univ. of Minnesota, Minneapolis). p.250-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Cosmic alpha-particle intensity was measured using nuclear emulsions in a balloon flight on July 16, 1959, when neutron-monitor count rates were near absolute minimum. The result is combined with other alpha-particle data and neutron rates in order to study Forbush-type short-term and long-term intensity variations, for four rigidity intervals. Regression curves are determined, and a suggested expression for modulation is examined. (M.J.T.)

25212 COSMIC RAY MODULATION BY INTERPLANETARY MAGNETIC FIELD. A. I. Kuzmin, G. F. Krymskii, P. A. Krivoshapkin, G. V. Skripin, N. P. Chirkov, and G. V. Shafer (Inst. of Cosmophysical Research and Aeronomy, Academy of Sciences, Siberian SSR). p.265-71 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Solar-flare produced cosmic rays and the secular, 27-day, and diurnal variations of galactic cosmic-ray intensity and energy with solar activity are reviewed. The effect of an expanding shell of a radial interplanetary magnetic field on cosmic-ray modulation is considered. The configuration of the interplanetary magnetic field to the north and south from the ecliptic plane is shown. (M.J.T.)

25213 ON THE PRIMARY COSMIC RAY SPECTRUM DERIVED FROM THE MEASUREMENTS OF IONIZATION ON BALLOON ASCENTS. N. W. Nerurkar (Physical Research Lab., Ahmedabad, India). p.272-6 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Balloon data on relative ionization due to cosmic rays as a function of atmospheric depth are given for measurements over Minneapolis, Minnesota, from Sept. 1959 to May 1963 and correlated with ground neutron monitor count rates. It is found that the ionization from galactic cosmic radiation varies with neutron ground readings independent of the type of solar modulation. These data plus yield functions of an ion chamber for rigidity from 0.5 to 16 Gv are used to derive the differential number spectrum as a function of rigidity at the top of the atmosphere. (M.J.T.)

25214 CHANGES IN THE COSMIC RAY SPECTRUM IN THE CURRENT SOLAR CYCLE. N. W. Nerurkar (Physical Research Lab., Ahmedabad, India). p.277-81 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on cosmic rays measured by an ion chamber in balloon flights over Thule from 1951 to 1962 are given as a function of atmospheric depth. The differential number spectrum of primary cosmic rays as a function of rigidity is derived from the data and compared with that from the data over Minneapolis. The variation of the exponent of the primary rigidity spectrum, and thus of the galactic cosmic-ray intensity, with solar activity is examined. (M.J.T.)

25215 THE DECREASE OF THE COSMIC RAY INTENSITY DURING THE 11-YEAR CYCLE. C. J. Hatton and P. L. Marsden (Univ. of Leeds, Eng.). p.282-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on cosmic-ray intensity variations recorded at several high-latitude sea-level stations from 1955 to 1961 are correlated with features of solar activity, including average sunspot number, numbers of big solar flares, and intensity of the 10.7-cm solar radio emission. It is found that there are active regions on the sun predominantly responsible for producing changes in the cosmic-ray modulating interplanetary magnetic field system. (M.J.T.)

25216 CHANGES IN THE RIGIDITY SPECTRUM OF COSMIC RAYS ASSOCIATED WITH GEOMAGNETIC DIS-

TURBANCES. Hachiro Takahashi (Iwate Univ., Morioka, Japan). p.291-4 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on the variations in primary cosmic-ray rigidity spectra, especially from data on meson and neutron intensities, are examined in correlation with the geomagnetic disturbance index A_p. It is found that the primary rigidity spectra during short-term variations and cosmic-ray storms change as a function of the magnitude of associated geomagnetic disturbances. The cause of the spectrum change is not due to the change in geomagnetic cutoff. (M.J.T.)

25217 THE RIGIDITY DEPENDENCE OF THE LONG- AND SHORT-TERM VARIATIONS IN COSMIC RADIATION. J. A. Lockwood and H. Razdan (Univ. of New Hampshire, Durham). p.295-301 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Pressure-corrected data from nucleon detectors at several stations were analyzed to examine the dependence of cosmic-ray rigidity spectrum variations on the time of observation in the solar cycle. Evidence for a strong hysteresis effect in the long-term variation, showing a different rigidity dependence during the decrease and recovery phases, is found, confirming previous results. The existence of the hysteresis effect during short-term (Forbush) decreases is found in one case; other Forbush decreases indicate that the rigidity dependence of the recovery phase is at no time greater than that of the decrease phase. (M.J.T.)

25218 THE RESPONSE OF MESON AND NEUTRON DETECTORS TO ANISOTROPY OF COSMIC RAYS. G. Subramanian (Physical Research Lab., Ahmedabad, India). p.302-6 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Calculations were made of the responses of cubical meson telescopes and of neutron monitors at equatorial and high-latitude stations (Huancayo, Kodaikanal, and Churchill) to anisotropy for various spectral and latitude dependences. It was assumed that the primary anisotropy outside the geomagnetic field can be resolved into diurnal and semidiurnal components. Results are presented for the reduction of the amplitudes of the two harmonic components and the shifts in the times of maxima of the first and second harmonics. (M.J.T.)

25219 THE NATURE OF THE DAILY VARIATION OF COSMI RAY INTENSITY DURING THE PERIOD OF 1958-1962. Vikram A. Sarabhai and G. Subramanian (Physical Research Lab., Ahmedabad, India). p.307-13 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A study is made of the frequency distributions of characteristics of the cosmic-ray-intensity daily variation from year to year with diminishing solar activity. Changes of position, strength, and energy spectrum of the anisotropy variations are considered. The peak-to-peak amplitude of the daily variation from the diurnal and semi-diurnal components and the times of maximum and minimum of the daily variation of intensity are considered for the Huancayo neutron monitor and the Churchill neutron monitor and meson telescope. (M.J.T.)

25220 PHASE ANTICIPATION IN TRAINS OF DIURNAL VARIATIONS OF COSMIC RAYS. M. Galli, F. Palmonari, and P. Randi (Universita, Bologna). p.317-21 of "International Conference on Cosmic Rays. Vol. 2" Bombay, Tata Inst. of Fundamental Research, 1964.

Meson data from Bologna, Tokyo, and Hobart for Feb. 1961 to March 1962 are considered. A statistical distribution of the phase shifts between one day and the next was made for diurnal oscillations of period 24 ± 10 hr. Autocorrelation analysis was used to examine the phase anticipation. Amplitude and phase behavior of the nonconstant part of the diurnal wave is presented. It is seen that there is a transient diurnal wave superimposed on the diurnal and semidiurnal components probably connected with the varying velocity of the solar wind. (M.J.T.)

25221 A 27-DAY RECURRENCE TENDENCY IN COSMIC RAY DIURNAL VARIATION WITH INVERSE PHASE. H. Ueno (Nagoya Univ., Japan), S. Sagisaka, S. Mori, and K. Nagashima. p.322-6 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

A 27-day quasiperiodic sequence of cosmic-ray diurnal-variation (DS) events with inverse phase (IP) was found during IGY. The DS phase was found to be between 6 and 18 hrs. The relation among these IP events, the position of the sun and earth during type-IV radio bursts, and polar-cap absorption and blackout is discussed, considering the possible existence of a disturbed region in interplanetary space and on the solar surface. (M.J.T.)

25222 THE ATMOSPHERIC CONTRIBUTION TO THE DIURNAL VARIATION OF THE HARD COMPONENT AT DEEP RIVER. M. Bercovitch, J. F. Steljes, and H. Carmichael (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.327-31 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The meson-intensity diurnal variation (d.v.) due to the daily temperature cycle in the atmosphere was investigated by comparing the d.v. in temperature-controlled high-count-rate neutron and scintillation-telescope meson monitors for April 1962 to March 1963. The ratio of vector average amplitudes of the neutron and meson d.v. was found to be constant after subtraction of the atmospheric d.v. from the meson amplitude. It is concluded, contrary to previous studies, that the atmospheric d.v. in the meson intensity is small relative to the mean observed meson d.v. (M.J.T.)

25223 VARIABILITY OF THE ENERGY DEPENDENCE OF THE COSMIC RAY ANISOTROPY. M. Bercovitch (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.332-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The ratio of the yearly average meson to neutron diurnal variation (d.v.) amplitudes deduced previously is used to investigate the average energy dependence of the anisotropy, for April 1962 to March 1963. Factors contributing to fluctuations of the A_M/A_N ratio—counting statistics, day-to-day variations of the atmospheric contribution to the meson amplitude, and short-term irregularities of the intensity baseline introduced into the d.v. analysis by subtraction of the 24-hour running average—are considered. Relative dispersions in A_M/A_N are found to be considerably larger than those from these factors; a residual dispersion of 30%, ascribed to the variability of the energy dependence of the anisotropy, is obtained. (M.J.T.)

25224 DIURNAL VARIATIONS IN COSMIC RAY MESON INTENSITY IN EAST AND WEST DIRECTIONS MEASURED AT MAKERERE. D. M. Thomson and T. Mathews (Makerere University Coll., Kampala, Uganda). p.338-42 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Diurnal variations in cosmic meson intensity were studied using two G-M telescopes inclined at 45° to the zenith in the east and west directions and an IGY neutron monitor, for 1958, 1960, and 1962-3. Corrections to the data for atmospheric pressure and temperature are described. The amplitudes of the first harmonic of meson-intensity variations in the east and west directions are presented and compared with those for neutron-intensity variations. (M.J.T.)

25225 EVIDENCE FOR A GENUINE SIDEREAL DAILY VARIATION OF COSMIC RAY INTENSITY AT ~40 M.W.E. UNDERGROUND AT HOBART IN 1961. R. M. Jacklyn (Dept. of External Affairs, Melbourne). p.345-9 of "International Conference on Cosmic Rays. Vol. 2," Bombay, Tata Inst. of Fundamental Research, 1964.

Data from two vertical telescopes, operating since Oct. 1957 were analyzed. It was found that, for the first year, the modulation of the solar daily variation (d.v.) was pro-

duced by a sidereal d.v. which also experienced semi-annual modulation of amplitude and phase. For following years, the times of maximum of the solar and the apparent sidereal d.v.'s remained significantly constant. The sequence of monthly mean values of phase and amplitude of the d.v. is given for 1958 to 1962. The effect of a sidereal component is seen in 1961, when the time of maximum is displaced from 1500 to 0700 LST. An estimate for the annual mean sidereal d.v. in 1961 was obtained by harmonic analysis. (M.J.T.)

25226 A COMPARISON OF SEVERAL METHODS OF CORRECTING COSMIC RAY MESON INTENSITY FOR ATMOSPHERIC TEMPERATURE VARIATIONS. H. Carmichael, M. Bercovitch, and J. F. Steljes (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.350-5 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data from a meson telescope and neutron monitor in a temperature-controlled building were correlated with atmospheric temperatures for the period from May 1962 to April 1963 to test the effectiveness of different methods of correcting meson monitor count rates for atmospheric temperature variations. The daily average counting rates of the meson monitor were fitted to regression equations, and values of the temperature regression coefficient found by the Duperier method, the Maeda formula, and the Dorman formula are plotted. (M.J.T.)

25227 A STUDY OF PERIODICAL AND QUASIPERIODICAL COSMIC RAY VARIATION ACCORDING TO THE DATA OF THE WORLD-WIDE NETWORK OF STATION AND USING CROSSED TELESCOPE. L. I. Dorman, V. I. Ivanov, O. I. Inozemtseva, I. E. Koshkarev, E. V. Kolomeets, L. A. Mirkin, V. T. Pivneva, G. A. Sergeeva, L. Kh. Shatashvili, and R. A. Chumbalova. p.356-69 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Studies were made of solar, sidereal, geomagnetic, and 27-day cosmic-ray intensity variations. Solar diurnal and half diurnal variations in the neutron component were studied using data of the world-wide network of stations for periods free from magnetic disturbance; changes of the amplitude and phase of the variations were analyzed as functions of solar activity, giving averages of the first and second harmonics and the sunspot numbers. The sidereal diurnal variation was investigated using data for geomagnetically quiet periods; the amplitude and phase of sidereal diurnal and half-diurnal variations were determined by harmonic analysis. The local diurnal anisotropy caused by an asymmetrical change of geomagnetic field was analyzed, calculating the effect of a magnetic storm. The 27-day variations were studied and explained assuming heterogeneities in the solar wind and interplanetary magnetic field. (M.J.T.)

25228 ON THE RELATION BETWEEN THE WORLD-WIDE DISTRIBUTION OF THE DIURNAL VARIATION OF THE COSMIC-RAY NEUTRON INTENSITY AND THE SUNSPOT NUMBERS. Tsunekichi Kanno (Fukushima Univ., Japan). p.370-4 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The relation between T_{mn} (the local time of maximum of the diurnal variation of cosmic-neutron intensity) and the relative sunspot numbers is discussed using data from the IGY period, and the world-wide T_{mn} distribution, calculated from an empirical formula, is compared with relative sunspot number. It was found that T_{mn} increases in low and middle latitudes and decreases in polar regions, as solar activity increases. Cosmic particles can be modulated by solar clouds existing relatively near the earth. The lines of force of the geomagnetic field may be assumed to bend westwards in space beyond the earth. (auth)

25229 DIURNAL VARIATION OF COSMIC RAYS NEAR THE GEOMAGNETIC POLES. S. P. Duggal and M. A. Pomerantz (The Franklin Inst., Swarthmore, Penna.). p.375-80 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Neutron monitor data from three polar (Thule, Resolute, and McMurdo) and one equatorial (Mina Aguilar) stations were recorded for 1958 to 1962 to study 24-hour variations over the declining phase of the solar cycle; the data were harmonically analyzed, removing secular variations by taking 24-hour running averages and rejecting data during disturbed periods. Results are presented graphically and discussed. It is concluded that significant modulation perpendicular to the plane of the ecliptic occurs during anomalous periods, lasting as long as several months, even though the average daily variation on a yearly basis is consistent with anisotropy in this plane. (M.J.T.)

25230 CHANGES IN THE PRIMARY COSMIC-RAY RIGIDITY SPECTRUM OVER A SOLAR CYCLE AS DERIVED FROM LATITUDE EFFECT. Ichiro Kondo (Univ. of Chicago), Masahiro Kodama, and Tadao Makino. p.383-5 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Nine surveys of the latitude effects of the cosmic-ray nucleon component at sea level, from 1954 to 1962, were analyzed. Cutoff rigidities were determined by numerical integration of cosmic-ray trajectories in the geomagnetic field, thus making it possible to compare intensity-rigidity curves derived in different phases of the solar cycle and at different parts of the world. The rigidity dependence of the fractional decrease in the primary differential flux for each survey is presented. Results indicate that the modulation of cosmic-ray intensity shows a different rigidity dependence before and after the solar maximum, related to the build-up and decay of the interplanetary magnetic modulating region. (M.J.T.)

25231 COSMIC RAY THRESHOLD RIGIDITIES DETERMINED FROM TRAJECTORY CALCULATIONS. Ichiro Kondo (Univ. of Chicago), Masahiro Kodama, and Tadao Makino. p.386-90 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Cosmic-ray cutoff rigidities were determined from data from 95 points on four ship routes, using an IBM 7090 to calculate orbits of the vertically incident particles at 0-1-Gv intervals. Resulting rigidity spectra are compared with those calculated by the Quenby and Wenk approximation. Causes of discrepancies in the data are examined, considering effects of cosmic rays from inclined directions and the use of the Finch and Leaton expression for the geomagnetic field. (M.J.T.)

25232 RIGIDITY DEPENDENCE OF THE 11-YEAR VARIATION. C. J. Hatton and P. L. Marsden (Univ. of Leeds, Eng.). p.391-5 of "International Conference on Cosmic Rays. Vol. 2" Bombay, Tata Inst. of Fundamental Research, 1964.

The rigidity dependence of the 11-year variation for the period 1954 to 1962 was studied by comparing the decrease and recovery of the cosmic-ray intensity recorded at high latitude with that of an equatorial station. Transient effects were eliminated by determining mean monthly intensities and omitting periods with transient decreases of greater than 1% amplitude. The data were fitted by an empirical modulating function and by the modulation function given by the Dorman modification of the solar wind theory. (M.J.T.)

25233 A STUDY OF VERTICAL CUT-OFF RIGIDITIES USING A SIXTH DEGREE SIMULATION OF THE GEOMAGNETIC FIELD. M. A. Shea (AVCO Corp., Wilmington, Mass.). p.396-400 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Discrepancies between studies of cosmic-ray intensity as a function of geomagnetic latitude are investigated by a rigorous determination of the cutoff rigidities. Data from the SOYA voyage from Japan to Antarctica and the 1960 airplane flight between Paris and the Canary Islands are employed

to calculate particle trajectories for various rigidities, using the McCracken method on a high-speed computer and the Finch and Leaton sixth degree expansion of the geomagnetic field. The cutoff rigidities predicted by this method are in better agreement with experimental values than previous predictions. (M.J.T.)

25234 ON COSMIC RAY CUT OFFS. Ernest C. Ray (Cornell Univ., Ithaca, N. Y.). p.401-4 of "International Conference on Cosmic Rays. Vol. 2" Bombay, Tata Inst. of Fundamental Research, 1964.

An integral, analogous to the Stoermer integral for a dipole magnetic field, was developed describing the motion of charged particles in geomagnetic fields as least complex as that of Finch and Leaton. A formula for the cutoff rigidity is derived from this integral, using the McIlwain L parameter for trapped radiation. (M.J.T.)

25235 MODULATION OF GALACTIC COSMIC RAYS BY INTERPLANETARY PLASMA. Vikram A. Sarabhai and G. Subramanian (Physical Research Lab., Ahmedabad, India). p.405-10 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The direction and energy spectra of the cosmic-ray anisotropy outside the influence of the geomagnetic field are derived for individual days during 1958 to 1962, by the method of best fit. The amplitudes and phases of the first and second harmonics of the daily variation observed by the Huancayo and Churchill neutron monitors and the Churchill cubical meson telescope are used. (M.J.T.)

25236 LATITUDE SURVEY OF COSMIC-RAY INTENSITY BY EXPLORER 7, OCTOBER 1959 TO FEBRUARY 1961. W. C. Lin, D. Venkatesan, and J. A. Van Allen (Univ. of Iowa, Iowa City). p.411-12 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Charged-particle intensity was surveyed over the latitudes ±50.5°, from 550 to 1100 km, using a G-M tube in the Explorer-7 satellite. Contributions by geomagnetically trapped particles were eliminated, and the sum of the absolute intensities of primary galactic cosmic rays and their charged-particle secondaries (albedo) produced in the atmosphere was obtained. (M.J.T.)

25237 REPORT OF WORKING GROUP. CORRECTIONS TO BE APPLIED TO THE DATA. R. M. Jacklyn. p.423-6 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Methods for correcting meson-telescope and neutron-monitor data for pressure variations are recommended, and precautions for barometric effects due to high winds, large and rapid pressure excursions, and low-latitude frictional effects are discussed. Recommendations for the recording of radiosonde data, including giving uniform pressure-height information and the source of European data, are mentioned. The inclusion of normalization factors used to correct data for counting efficiency changes is urged. (M.J.T.)

25238 RIGIDITY AND ENERGY SPECTRA OF PRIMARY COSMIC RAYS. H. Komori (Yamanashi Univ., Kofu, Japan). p.437-40 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Primary cosmic-ray data for the past 12 years were divided into those from disturbed and nondisturbed periods. Expressions for the integral rigidity and energy spectra in terms of the cutoff rigidity and energy respectively were assumed, and the constants in these expressions were determined by the least squares method on an OKITAC 5090 computer. Results for protons, alpha particles, and elements with average A = 14.0 and 30.5 during nondisturbed periods are presented, and solar-wind modulation effects are noted. (M.J.T.)

25239 SEA LEVEL COSMIC RAY INTENSITY AND THRESHOLD RIGIDITY AROUND THE SOUTH AFRICAN MAGNETIC ANOMALY. N. F. du Plooy, G. J. Kuhn, J. P. Maree, P. H. Stoker, and A. J. Van der Walt (Potchefstroom Univ. for C.H.E., South Africa). p.441-3 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Neutron-monitor count rates recorded on a ship voyage from Dec. 1962 to Apr. 1963 over the area 10° W to 40° E longitude and 30 to 70° S latitude are presented and correlated with Quenby and Wenk calculated threshold rigidities. (M.J.T.)

25240 MAIN FEATURES OF FORBUSH-TYPE DECREASE AND SMALL COSMIC-RAYS FLARE DURING INTENSITY RECOVERY. B. M. Vladimirskii and A. A. Stepanyan. p.444-53 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on Forbush decreases are considered in terms of possible mechanisms—modulation by a regular magnetic field, cosmic-ray diffusion in a chaotic magnetic field, and modulation by an electric field. The types and position of solar flares responsible for the decreases are studied. (M.J.T.)

25241 FORBUSH EFFECT AND DISTURBANCES OF INTERPLANETARY MAGNETIC FIELD. G. F. Krymskii, A. I. Kuzmin, and G. V. Shafer (Inst. of Cosmophysical Research and Aeronomy, Academy of Sciences, Siberian SSR). p.454-9 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

Data on the energy spectra of Forbush effects are used to deduce numerical values of the energy dependence of the transparency of shell walls of the interplanetary magnetic transition region which separates the region of decreasing cosmic-ray intensity between the earth and the sun from the rest of space. (M.J.T.)

25242 ENERGY AND SPACE CHARACTERISTICS OF COSMIC RAY ANISOTROPY. A. I. Kuzmin, G. F. Krymskii, and G. V. Shripin (Inst. of Cosmophysical Research and Aeronomy, Academy of Sciences, Siberian SSR). p.460-1 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The contribution of temperature changes in the atmosphere to the diurnal variation of the meson component was calculated by the methods of temperature coefficients and of crossed telescopes. Data on mean diurnal variations at different depths in the vertical direction and in southern and northern directions 30° from the zenith are used to obtain parameters of the variation energy spectrum. It is found that the energy spectrum of the diurnal variation becomes softer with decreasing solar activity. (M.J.T.)

25243 ASYMMETRY OF COSMIC RAY VARIATIONS AND STRUCTURE OF INTERPLANETARY MAGNETIC FIELD. N. P. Chirkov, A. I. Kuzmin, and G. F. Krymskii (Inst. of Cosmophysical Research and Aeronomy, Academy of Sciences, Siberian SSR). p.462-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The average monthly neutron and meson intensity, corrected for pressure and temperature in Yakutsk and Tiksi Bay are given for 1954 to 1961; data on secular variations, Forbush decreases, and 27-day variations are considered. The method of a function of the specific angular sensitivity is proposed for the analysis of the spatial distribution of the variations. Effects of the asymmetry of cosmic-ray variations are examined and discussed. (M.J.T.)

25244 A NEW METHOD FOR THE ESTIMATION OF THE PRIMARY ENERGY OF COSMIC RAY JETS. M. L. Shen and M. F. Kaplon (Univ. of Rochester, N. Y.). 90p. (CONF-641004-6). (UR-875-63)

From American Physical Society, Chicago.

Methods of determining the primary energy of cosmic-ray jets are reviewed, and the corrections which have been developed to improve the basic assumptions are discussed to clarify the limit of this applicability. To avoid the disadvantages inherent in the usual methods, a new method was developed for determining the primary energy of cosmic-

ray jets, based mainly on the constancy of transverse momentum of the charged secondary shower particles and which is free of the usual assumptions employed. Nuclear interactions induced by 28.5-Bev protons and 17-Bev mesons(π^-) in emulsion were analyzed to test the validity of this method, and the results are compared with those obtained by using Castagnoli's method and the E_{ch}-method. The agreement is much better with the new method. The half widths of the γ_c (Lorentz factor of the center of mass system) distributions are greatly reduced and appear to be consistent with the assumption that they are mainly due to the Fermi momentum of the target nucleon in the target nuclei. (auth)

Criticality Studies

See also REACTOR TECHNOLOGY — Criticality Studies.

25245 (HW-84369(p.45-51)) CRITICALITY OF PLUTONIUM NITRATE SOLUTIONS IN SPHERICAL GEOMETRY. R. C. Lloyd, D. R. Skeen, and S. R. Bierman (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Critical experiments were continued with plutonium nitrate solutions (4.6% ^{240}Pu) in spherical geometry. The experimental vessel in current use is a 15.2-in.-dia stainless steel sphere (30.2 liter volume) having a wall thickness of 0.048 in. Experiments were conducted with the vessel reflected by water and concrete; experiments were also made with the vessel unreflected. The concrete reflector was separated from the vessel by a 3⅝-in. air gap. During the course of the experiments, the effect on criticality of the vessel wall was evaluated. Gold foil traverses were made of a number of critical solutions to determine their respective critical bucklings. Also, pulsed neutron source measurements were made on a number of the assemblies. Neutron lifetime values are reported for the full bare critical spheres. (auth)

25246 (HW-84369(p.53-4)) UNREFLECTED CRITICAL MASS OF Pu^{238} METAL. L. L. Carter (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

A series of Monte Carlo calculations was carried out to determine the bare spherical critical masses of ^{238}Pu and ^{239}Pu in metallic form. A summary of the Monte Carlo results is included. (J.R.D.)

Direct Energy Conversion

25247 (AFCRL-64-409) THERMIONIC CONVERTER RESEARCH STUDIES. Final Report. J. M. Houston and H. F. Webster (Research Lab., General Electric Co., Schenectady, N. Y.). Oct. 1964. Contract AF19(604)-8424. 156p. (AD-607400) $5.00(CFSTI)

The work accomplished covered research studies of a cesium thermionic converter incorporating a thorium dispenser cathode, studies of electrode materials both polycrystalline and single crystal, and the development of research techniques associated with the thermionic converters. (auth)

25248 MAGNETOHYDRODYNAMIC GENERATORS WITH NONEQUILIBRIUM IONIZATION. Jack L. Kerrebrock (Massachusetts Inst. of Tech., Cambridge). AIAA (Am. Inst. Aeron. Astronaut) J., 3: 591-601(Apr. 1965).

A review of experimental and theoretical work on MHD generators with nonequilibrium ionization is presented, covering both nonequilibrium plasma behavior and generator characteristics. A two-temperature theory including radiation corrections is proposed, which will predict the electric conductivity of the plasma rather accurately. (D.C.W.)

25249 NONEQUILIBRIUM IONIZATION IN WET ALKALI METAL VAPORS. John Marlin Smith (General Electric Co., Philadelphia). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 648-51(Apr. 1965).

A theoretical model for the transport of electrons in a wet vapor was formulated. The medium is considered of electrons, neutral gas atoms, positvely charged atomic ions, and charged vapor droplets. The degree of ionization of the gas atoms is assumed to be given by Saha's Law evaluated at the electron temperature, whereas the degree of charging of the vapor droplets is obtained by equating the random electron current in the gas to the thermionic emission current of the vapor droplet at its internal temperature. The electron temperature is determined by equating the Joule heating rate of the electrons to their rate of energy loss due to elastic electron-atom, electron-ion, and electron-droplet collisions and inelastic electron-droplet collisions. The droplet internal temperature is determined by equating the rate of droplet heating due to electron bombardment to the rate of cooling due to atom and ion bombardment. The preceding theory is applied to MHD generator considerations for which the predominant effect of the droplets is found to be the absorption of free electrons from the system. The depression of electron density is found to be most severe at high-percent moisture and for small droplets. (auth)

25250 HALL POTENTIALS IN NONEQUILIBRIUM MHD GENERATORS. Arthur Sherman (General Electric Co., Valley Forge, Penna.). AIAA (Am. Inst. Aeron. Astronaut) J., 3: 783-4(Apr. 1965).

In experiments on MHD generators using self-induced electric fields to create nonequilibrium ionization, Hall voltage was obtained lower than those predicted. An analysis is summarized in which the possibility that this observation might be explained in terms of shorting along the insulator surfaces. (D.C.W.)

25251 SINGULAR SURFACES OF ORDER ONE IN MAGNETOGASDYNAMICS. C. N. Kaul (Indian Inst. of Tech., Kharagpur, India). Appl. Sci. Res., Sect. B, 11: 382-90(1964-5).

Singular surfaces of order one in MHD are discussed by applying the compatibility conditions due to Thomas. The propagation of the "transverse type" of singular surface is discussed at length, and an expression is obtained for the variation of its "strength." It is shown that the strength of a plane transverse singular surface remains constant when moving in a uniform medium at rest. For propagation in a non-uniform medium, the strength is, however, shown to vary; and an expression is derived giving the variation. (auth)

25252 INFLUENCE OF MAGNETIC FIELD ON CESIUM THERMIONIC ENERGY CONVERTER. J. Kramar (Research Inst. of Electrical Engineering, Bechovice, Czechoslovakia). Czech. J. Phys., 15: 190-200(1965).

The influence of the magnetic field upon the electric current of a thermionic converter was investigated, presupposing the approach to conditions in a low-pressure cesium converter. The distribution of the starting velocities of the emitted electrons was considered first to be independent of the angle from the perpendicular to the emitter plane and second to vary according to the cosine law. The magnetic field effect from the converter current was calculated and compared with the calculations by Schock and Block; the effect of the external magnetic field was verified by measurements on a solar thermionic converter prototype. (auth)

25253 SOME CHARACTERISTICS OF A CESIUM PLASMA TRANSFORMER. O. Venek. Elektrotech. Casopis, No. 6, 379-81(1964).

An experimental investigation is reported of a plasma transformer design based on a gas-filled diode consisting of two parallel electrodes, a hot tantalum cathode and a cold nickel anode positioned in a metallic cesium cylinder. A tungsten spring holds the cathode in place, and copper wires carry the cathode heating current. The whole system is housed in a glass tube. Ionization of the cesium vapor occurs at the cathode surface, and its pressure is temper-

ature-regulated. This method was used as it makes possible the solution to many problems and because the design and physical basis of the apparatus are very simple. The volt-ampere characteristics were measured in the cesium vapor pressure region from 0 to 1.5×10^{-2} mm Hg, at 1.8×10^{-4} mm Hg, and in the cathode temperature range from 750 to 2,000°K. The efficiency was measured in the whole operating range in order to determine optimum transformer characteristics and to verify the theoretical conclusions. Comparison of the measured values shows that the voltage at the output when the current is low decreases with increased cesium vapor pressure, which can be explained by increased ionic current. Cathode output change was observed in the above range of parameters. It is concluded that the space-charge effect of electrons emitted by the tantalum cathode at a temperature of around 2,000°K can be completely neutralized by the cesium vapor ions even at ambient temperature. Efficiency was measured as the ratio of the maximum output obtained when the load resistance is changing, and as the measure of the applied power. The measurement results are in agreement with the theoretical results, given constant cesium vapor pressure. Efficiency measurements in the region of constant cathode output are in agreement with the calculated values. The local efficiency maximum is in the region of low cathode temperature, which change in cathode output results from the absorption of Cs atoms on the cathode surface. This phenomenon is useful when a low-temperature heat source is required. (CFSTI)

25254 LIQUID-METAL MAGNETOHYDRODYNAMICS. Michael Petrick (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 2: No. 3, 137-40; 45-51 (Mar. 1965).

The merits of various MHD cycles are investigated to establish the potential of the liquid-metal concept for commercial power systems. Schematic diagrams and analysis results are given for a two-component two-phase cycle proposed by Elliott, the Prem two-phase one- or two-component cycle, a two-phase one-component cycle of Petrick and Lee, and the condensing injector cycle of Jackson and Brown. Overall efficiencies and economics of liquid-metal MHD topping cycles for commercial application are considered. Plasma and liquid-metal MHD cycles are compared. (M.J.T.)

25255 THERMIONIC DIRECT CONVERSION UNITS. P. J. Duncton. Nucl. Energy, 74-9(Mar. 1965).

The principles and status of thermionic convertors are summarized, including diode and triode devices, combustion and isotopic heat sources, and potential uses of thermionic devices. (D.C.W.)

25256 A NON-LINEAR ANALYSIS OF THE TRANSIENT BEHAVIOR OF THERMOELECTRIC GENERATORS WITH TEMPERATURE DEPENDENT PHYSICAL PARAMETERS. David Tai-ko Shaw (State Univ. of New York, Buffalo). 5p. (CONF-654-88)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964).

An analytical approach to the problem of the nonlinear transient behavior of thermoelectric generators with time-dependent heat input function is introduced. The problems of predicting the output current as a function of time, and that of predicting the temperature distributions in the thermoelements as a function of both time and distance are solved, using logarithmic and other transformations to remove the singularities in the system, and by applying the technique of the special expansion of Jacobi. (L.B.S.)

25257 THE PRESENT STATUS OF MAGNETOHYDRODYNAMIC POWER GENERATION. S. Way (Westinghouse Research and Development Center, Pittsburgh). 23p. (CONF-650105-6)

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

The main effort directed toward the generation of power by magnetohydrodynamics is in the field of central station power; other applications lie in long range space propulsion and special purpose industrial power systems. The potential advantages of the combined MHD-steam plant are discussed. The developments in MHD power generation are briefly reviewed, and the present status is considered in terms of studies of gas properties and conductivity, combustion systems, generator walls, electrodes, air preheaters, seed recovery, and magnets. (L.B.S.)

25258 RECENT PROGRESS IN HIGH SPECIFIC IMPULSE THERMO-IONIC ACCELERATION. Adriano C. Ducati, Gabriel M. Giannini, and E. Muehlberger (Giannini Scientific Corp., Santa Ana, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-96, 11p, $1.00. (CONF-650108-7)

From AIAA 2nd Aerospace Sciences Meeting, New York.

Developments in the thermionic engine are discussed, including improved performance, increase of specific impulse, and lifetime demonstrations, obtained through extensive testing. Preliminary data comparing performances of D and H propellant are given. Recent experiments in the discrimination of loss mechanisms in plasma accelerators were reported. The production of a thermionic cathode jet is described, and measured performance data and photographs are presented. (M.J.T.)

25259 PROCESSES FOR CONVERTING HEAT INTO MECHANICAL WORK. Franz Pauker. British Patent 967,493. Aug. 26, 1964. Priority date Nov. 20, 1959, Austria.

A process and plant are described for converting heat as from a nuclear reactor into mechanical work in at least two different conversion processes using different working media. Both heat energy still contained in the working medium of the first conversion process after the performance of mechanical work and an additional quantity of heat are supplied to the working medium of a succeeding conversion process from which mechanical energy and, if desired, heating or process steam are recovered. Special considerations are given to ways to increase to the highest possible value in any given case the overall efficiencies of each process, one of which succeeds another, by dividing the quantity of heat supplied to the overall process so that the ratio of the quantity supplied to the first conversion process to the additional quantity supplied to the succeeding conversion process is as high as possible. The entire heat converted in the succeeding conversion process is transmitted to the working medium by heat exchange, and the additional quantity of heat supplied to the succeeding conversion process to raise the temperature and pressure ranges and the temperature drop during the heat exchange are controlled so that the efficiency of the overall process is brought to the highest achievable value. (B.L.M.)

25260 IMPROVEMENTS IN OR RELATING TO THERMIONIC APPARATUS. (to General Dynamics Corp.). British Patent 976,814. Dec. 2, 1964. Priority date Nov. 15, 1960, United States.

A thermionic apparatus particularly applicable to removing deposited material from the surface of an electrode and redepositing the material on the surface of a second electrode is described. The apparatus consists of two electrodes spaced apart, the second of which is electrically insulated from the first and adapted to operate at lower temperatures than the first, and a carrier gas. The carrier gas is capable of reacting with a material at the second electrode to form a compound that is vaporized and then decomposed at the first electrode to deposit at least part of the material on the first electrode. The apparatus is also applicable to the usual direct heat-to-electricity conversion in solar generators, atomic reactors for electric power plants, and the like. (B.L.M.)

25261 IMPROVEMENTS IN THERMIONIC ENERGY CONVERTERS. (to Brown, Boveri, and Cie AG). British Patent 977,954. Dec. 16, 1964. Priority date July 10, 1962, Germany.

A plate thermidiode is described that has a liquid collector and a solid emitter. The solid emitter, e.g., is carried in a sintered body such as a ZrC plate, and both emitter and sintered body are preferably enclosed by a

lateral radiation shield. The emitter, collector, and sintered body are all contained within a sealed metal housing part of which is formed by a bellows of a metal having a high electrical resistance. In order to improve the mechanical strength of the diode, an insulating ring may be provided between each fold of the metal bellows. If it is necessary for the emitter and collector to have large surface areas, the body of sintered material and the emitter may both be divided into a plurality of units each of which is screened by a frame of a temperature resistant material such as W, and all the units are mounted on a common base plate. (B.L.M.)

25262 MAGNETOHYDRODYNAMIC GENERATOR. Heinz Goeschel and Friedrich Burhorn (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,160,768. Dec. 8, 1964. Priority date June 20, 1961, Germany.

A magnetohydrodynamic generator is described for the direct conversion of thermal energy to electrical energy. The generator comprises elongated plasma-generating means and magnetic means for producing a magnetic field transverse to the length of the plasma-generating means. The plasma generating means includes opposite lateral elongated walls having opposing electrode pairs displaceable toward each other for compensating wear of the electrodes. A photoelectric system extends along the interior of the plasma-generating means and defines a datum position for the elctrodes. An electrode drive means is provided for each of the tubular electrode structures that contain sinterable, electrically conducting material. A regulating device responsive to the photoelectric system and connected to the respective drive means periodically advances the electrodes toward the datum position. (B.L.M.)

Elementary Particles and Radiations

Refer also to abstracts 25138, 25400, 25469, and 25537.

25263 (IS-987) ON THE VALIDITY OF THE POLE APPROXIMATION FOR ONE-PARTICLE EXCHANGES. J. Cumming, K. E. Lassila, and J. McEwan (Ames Lab., Iowa State Univ. of Sciences and Tech.). Sept. 3, 1964. Contract [W-7405-eng-42]. 12p. (CONF-640606-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Physical Society Summer Meeting, Denver.

The validity of the pole approximation, which treats particles as approximately stable, is examined. The manner in which instability affects one meson exchanges between two nucleons is considered. (C.E.S.)

25264 (NYO-2262-86) ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS AT 903 Mev (thesis). Internal Report No. 108. Merlin Gene Taylor (Brown Univ., Providence, R. I.). Feb. 1965. Contract [AT(30-1)-2262]. 58p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The meson (π^-)-proton interaction was investigated at 903 Mev using a hydrogen bubble chamber. The measuring techniques and event construction and selection are discussed. The elastic scattering cross sections and angular distributions were determined. (C.E.S.)

25265 (UCRL-11776) PHYSICS DIVISION SEMIANNUAL REPORT MAY–OCTOBER 1964. (Lawrence Radiation Lab., Univ. of California, Berkeley). Nov. 16, 1964. Contract W-7405-eng-48. 73p. Dep.; $3.00(cy), 2(mn) CFSTI.

Research using bubble chambers is summarized along with work on data reduction and programming. Results of research on strange particles and pions is also reported along with space research and development of track analyzing microscopes. Theoretical work in physics is summarized, and other work devoted primarily to elementary particles is reported. A summary of work on accelerator operation and development is included. (J.R.D.)

25266 (UCRL-11961) ON THE CLUSTER STRUCTURE OF THE S MATRIX (thesis). James Hamilton Crichton (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 9, 1965. Contract W-7405-eng-48. 132p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Conditions imposed on the S matrix by the requirement that interactions between elementary particles be of short range are studied. Two distinct properties of elementary-particle interactions, so-called cluster properties, are considered specifically: that interactions between particles proceed independently of the presence of other particles far away in space and time; and that multiparticle scattering processes occur predominantly by means of a freely propagating particle connecting, in a causal way, successive scattering processes that involve fewer particles. These properties are formulated as limiting equations involving plane-wave S-matrix elements. These equations imply a structure in the S matrix, which is denoted the cluster structure. The independence of the cluster properties from the usually-postulated properties of the S matrix, namely Lorentz invariance and unitarity, is shown. The S operators obtained from the Feynman perturbation theory and from the LSZ formalism are shown to satisfy both cluster properties. It is claimed that any realistic theory of elementary-particle interactions must satisfy these properties. (auth)

25267 ON THE CONVERGENCE OF THE PERATIZATION METHOD. I. Montvay (Roland Eotvos Univ., Budapest). Acta Phys. Acad. Sci. Hung., 18: 119-28(1965).

Recently Feinberg and Pais have found a method for the solution of the integral equation summing the ladder graphs in the theory of weak interactions. The convergence of their method in the case of zero incoming momenta is shown, and the connection between the regularized and unregularized equations is examined. It is shown that it is possible to obtain the results of the regularization procedure directly from the original, unregularized equation. (auth)

25268 THE ENERGY AND MOMENTUM DEPENDENCE OF np CHARGE EXCHANGE SCATTERING. Richard Wilson (Harvard Univ., Cambridge, Mass.) Ann. Phys. (N. Y.), 32: 193-200(Apr. 1965).

The n-p charge exchange and ordinary scattering are presented as a function of the square of the invariant four-momentum transfer. It is noted that from 91 Mev to 2840 Mev the variation with the incident energy and the variation with the four-momentum transfer are independent. The significance of this is discussed. (auth)

25269 BROKEN SU(3) × SU(3) × SU(3) × SU(3) SYMMETRY. P. G. O. Freund and Y. Nambu (Univ. of Chicago). Ann. Phys. (N. Y.), 32: 201-17(Apr. 1965). (COO-264-219; EFINS-64-53)

It is argued that the "Eightfold Way" version of SU(3) symmetry should be extended to a product of up to four separate and badly broken SU(3) groups, including the γ_5 type SU(3) symmetry. A hierarchy of subgroups (or subalgebras) is considered within this framework, and two candidates are found to be interesting in view of experimental evidence. The main features of the theory are: the baryons belong to nonet; there is an octet of axial vector gauge mesons in addition to one or two octets of vector mesons; and pseudoscalar and scalar mesons exist as "incomplete" multiplets arising from spontaneous breakdown of symmetry. (auth)

25270 ON BJORKEN—HELLESEN TRANSFORMATION. W. Krolikowski (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 13: 77-8(1965).

The formulas determining the first order mixing of fields corresponding to $\frac{1}{2}^+$ and 0^- octets were applied by Bjorken and Hellesen (Physics Letters, 12, 141(1964)) to SU_3 invariant Yukawa strong interactions with pseudovector coupling in order to derive effective nonleptonic weak interactions. The conditions imposed on this transformation are discussed. (C.E.S.)

25271 EXPERIMENTAL METHODS IN ELEMENTARY PARTICLE PHYSICS. J. Litvak (Comision Nacional de

Energia Atomica, Buenos Aires). Ciencia Invest. (Buenos Aires), 20: 100-18(Mar. 1964). (In Spanish)

A synthesis of the most important of the recent discoveries, together with a sketch of the methods used for the study of elementary particles, is presented. The discussion is grouped chronologically covering the discovery of new particles or resonances (systems that decay into mesons(π), systems that decay into mesons(K), and systems that decay into nucleons) and the establishment of the existence of two types of neutrinos. (J.S.R.)

25272 RADIATION FROM THE OPEN END OF SEMI-INFINITE IDEALLY CONDUCTING SEMI-PLANES. Yu. M. Aivazyan (Central Scientific-Research Physics-Technical Lab., Armenian Academy of Sciences USSR). Dokl. Akad. Nauk Arm. SSR, 39: 279-82(1964). (In Russian)

The radiation emitted during the escape of a charged particle from a system of semi-infinite ideally conducting plates is determined. The limiting case where the distance between the plates approaches zero is considered. Equations are derived for the electric-field components, which go to zero on the walls of the nth waveguide. Expressions are then obtained for the intensity of the emitted electromagnetic radiation in free space. In the limiting case, these expressions give the intensity of the transition radiation of a charged particle emitted with constant velocity from a medium with zero conductivity in one direction and infinite conductivity in the other. (M.J.T.)

25273 ON THE NATURE OF THE ELECTRON. PART II. J. L. Salpeter. IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 2: 96-101(Apr. 1965).

The development of quantum electrodynamics as a tool for dealing with a pointlike electron that has an electrostatic energy that appears to become infinite is reviewed. The discovery of the fact that the principle of the conservation of parity is violated in beta decay is discussed, and an attempt is made to explain the full significance of this discovery. (C.E.S)

25274 INFLUENCE OF INELASTIC CROSS SECTION ON MULTIPLE COULOMB SCATTERING. Prem K. Aditya (Indian Inst. of Tech., New Delhi, India). Indian J. Phys., 38: 630-4(Dec. 1964).

The influence of eliminating large-angle scatters by cut-off was considered for protons and mesons (μ) of high energy. It was found that the proton distribution lacks in large-angle scatters, when compared with the meson (μ) spectrum, presumably on account of the inelastic interaction cross section. (auth)

25275 ELASTIC π^--p SCATTERING AT 4 Gev/c. A. Zlateva, P. Markov, T. Todorov, and Kh. Chernev. Izv. Fiz. Inst. s Aneb, Bulgar. Akad, Nauk., 12: 77-91(1964) (In Bulgarian)

The elastic π^--p interaction at 4 Bev/c was investigated using nuclear emulsions. 257 elastic events were identified, to which were added 115 elastic events observed elsewhere. The differential cross sections were calculated on the basis of 359 events. The elastic cross section in the angle interval of 3 to 15° in the center-of-mass system is 2.8 ± 0.3 mb. The data were fitted to a two-parameter curve. Within the limits of errors, the experimental data are in agreement with the prediction of the optical theorem for the forward scattering amplitude. (D.C.W.)

25276 PION-NUCLEON SCATTERING AND J = 2, T = 0 PION-PION INTERACTION. Charles Thompson (Applied Science, Minneapolis). J. Phys. Soc. Japan, 20: 297-302(Mar. 1965).

The effect of the J = 2, T = 0, $\pi-\pi$ interaction on the $\pi-N$ invariant amplitude $B^{(+)}$ is analyzed. It was found that the $\pi-N$ scattering data is inconsistent with a J = 2, T = 0, $\pi-\pi$ phase, due to δ_2^0, which rises to above 13° around 650 Mev. From the data it is impossible to say whether the results correspond to a resonant phase or only a sharp peak in the corresponding absorptive part of the amplitude. (auth)

25277 DEPOLARIZATION OF μ^+ MESONS IN CONDENSED MEDIA. V. G. Nosov and I. V. Yakoleva (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 68: 609-31(July 1965).

A theory of μ^+ meson depolarization in condensed matter is developed. It is shown that the depolarization of a muonium electron in a medium is in general maintained, but is suppressed when the muonium enters into chemical reaction, which occurs long before its decay. Using experimental data on the depolarization of μ^+ mesons in an emulsion the parameters entering the formulas of the phenomenological theory are determined and the asymptotic polarization curve in strong magnetic fields is derived. Several possible mechanisms of the depolarization of a muonium electron as well as some problems of the chemistry of muonium are discussed. The case of substances with a large dielectric constant and its weakly pronounced frequency dispersion is considered. The theory is generalized for the case when the depolarization of a μ^+ meson is due to multiple charge exchange of muonium into μ^+ meson and vice versa. (auth)

25278 ELECTROMAGNETIC MASSES OF BARYONS AND UNITARY SYMMETRY. S. Iwao (Universitat, Bern). Nucl. Phys., 68: 632-40(July 1965).

Electromagnetic masses of the octet and the decuplet baryons are investigated in the (symmetry-breaking) unitary symmetry model of Gell-Mann and Ne'eman. The symmetry breaking arising from the medium strong interaction is introduced into the electromagnetic mass operator in the direct product form of the SU_3 group. The masses of the decuplet baryons are found to satisfy the relation $3M(N^{*+}) - 3M(N^{*0}) = M(N^{*++}) - M(N^{*-})$. An attempt is made to give a clear physical interpretation of the various theoretical relations between the electromagnetic masses of the octet baryons and to derive some useful information. First the isotensor contribution is found to be small (about 20%) compared to the isovector one. It is well known that in low-energy nuclear physics the former is negligibly small compared to the latter. Assuming then a similar effect for the decuplet baryons, two more approximate relations, $M(N^{*+}) - M(N^{*0}) \approx M(N^{*++}) - M(N^{*+})$ and $M(Y_1^{*+}) - M(Y_1^{*0}) \approx M(Y_1^{*0}) - M(Y_1^{*-})$ are obtained. Moreover the isoscalar and the isovector contributions are found to be small if they arise from the operators belonging to the highest irreducible representation of the problem in question. From the detailed analysis of the transient masses (one is purely electromagnetic and the other is mixed strong and electromagnetic) the effect of non-electromagnetic origin due to the second-order symmetry breaking is determined. The nature of the electromagnetic masses for the baryons and the nucleides need not necessarily be the same but that of the various contributions obtained from the octet baryons should remain the same for the decuplet baryons if they arise from the same physical origin of the symmetries. (auth)

25279 DEUTERON STRIPPING ON K MESONS WITH HYPERON RESONANCES. V. B. Mandelzveig (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys., 68: 641-8(July 1965).

Angular distributions for the production of hyperon resonances in the deuteron stripping on K mesons ($K^- + d \rightarrow Y + n$) are calculated in the pole approximation. The effect of elastic and inelastic processes in the final state (triangle diagrams) is estimated. The results obtained make it possible to determine experimentally the quantum numbers (spins and parity) of hyperon resonances (specific calculations are made for the resonances Σ_{1385} and Λ_{1405}). (auth)

25280 ANALYSIS OF ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN ULTRA HIGH ENERGY NUCLEON-NUCLEON COLLISIONS. R. Raczka and A. Raczka (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 68: 649-56(July 1965).

Starting from the exact expression for a transition probability in the relativistic angular momentum representation and using some approximations following from the assumed peripherality of collisions an expression for the angular distribution of secondary particles was obtained. The differential and integral angular distributions calculated for

the energies 10^3, 10^4, 10^5 Bev, lead to a natural explanation of the appearance of two maxima in the angular distributions. (auth)

25281 THE PROTON SPECTRUM IN INELASTIC π^--N COLLISIONS. V. V. Glagolev and K. D. Tolstov (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 68: 657-9(July 1965).

Experimental data are compared with respect to spectra and average number of protons in elastic $\pi^- - N$ scattering at 7 Bev. It is shown that at present there are no sufficient data to conclude that there are two maxima in the momentum spectra of protons, the explanation of which would require a complicated resonance variation of the $\pi - \pi$ interaction cross section with energy. (auth)

25282 REGGE HYPOTHESIS AND SPIN STRUCTURE OF FIVE-POINT AMPLITUDES. I. A. Verdiev (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 68: 673-90(July 1965).

The processes $\pi + N \rightarrow N + \pi + \pi$, $\gamma + N \rightarrow N + \pi + \pi$, $\pi + N \rightarrow N + \pi + \gamma$ are considered with the aid of the simplest reggeon graphs. The spin structure of helical amplitudes, differential cross sections, and the formulas for polarization of final particles are obtained in the case of boson reggeons. The isospin relations of the reaction cross sections are also considered. (auth)

25283 K_1^0 REGENERATION BY MAGNETIC FIELD AND APPARENT CP VIOLATION. Richard Spitzer (Univ. of California, Livermore). Nucl. Phys., 68: 691-4(July 1965). (UCRL-12068-T)

The recent experiments on 2π decay modes of the neutral K meson at large distances from the target are interpreted on the basis of previous theoretical work as K_1^0 regeneration by the longitudinal magnetic field. (auth)

25284 VECTOR BOSON ELECTRODYNAMICS. R. A. Shaffer (Vanderbilt Univ., Nashville). Nuovo Cimento (10), 37: 1-8(May 1, 1965).

It is well known that the divergences obtained in perturbation theories involving vector bosons are not as severe as the forms of the interaction lagrangians would suggest. General properties of the divergences encountered in the minimal electrodynamics of vector bosons are noted, and the expressions which describe a number of processes occurring in such a theory are examined. It is found that the order of the divergences of these expressions is no greater than that of the corresponding expressions in scalar electrodynamics. (auth)

25285 A RENORMALIZED, GHOST-FREE LEE MODEL. A. Garcia and F. Morey (Universidad, Cuyo, Philippine Islands). Nuovo Cimento (10), 37: 9-19(May 1, 1965).

A dispersion relation model is constructed so as to reproduce the results of a Lee model. This allows to compute explicitly the boson form factor; with it the renormalization constants can be shown to be incorrectly defined, even though the model can be regularized. A new method of solution is proposed with well-defined renormalization constants and free from ghost states. (auth)

25286 RENORMALIZATIONS AND PROPERTIES OF S MATRICES, NON-RELATIVISTIC AND RELATIVISTIC, RESULTING FROM FERMI COUPLINGS. A. Jacquemin and B. Jouvet (College de France, Paris). Nuovo Cimento (10), 37: 20-61(May 1, 1965). (In French)

An attempt is made to disentangle the various classes of infinities occurring in the local Fermi-coupling S-matrices and to give rules for curing them. The simplified model in which the scattering is due to a central potential on which is superposed a contact interaction which may act in the $l = 0$ or $l = 1$ waves is studied. The S-matrix is obtained explicitly and illustrated by soluble examples for a regular and a singular potential. This enables one to define vertex and vacuum polarization functions in terms of the wave functions of the Schrödinger equation without the contact term. It is shown that the total contribution of the contact term to the S-matrix is null. Nevertheless finite results are obtained after renormalizing the vertex function and the contact interaction constant. If a bound state exists, renormalization may be carried out in a different fashion, and the equivalence of the contact coupling theory with a field-theoretical model of the composite particle is established. The asymptotic behavior of the S-matrix and of the vertex function is studied, and their relation to the renormalization constants is pointed out. After this analysis is extended to the relativistic Fermi S-matrix it is suggested that an asymptotic bootstrap would avoid the difficulties connected with infinities. The overall renormalizability of the Fermi S-matrix is proved under two sufficient conditions. An approximation which, fulfilling these conditions, may constitute the first step of a convergent calculation is deduced. The interest of studying the theories which would violate one of these conditions is stressed. (auth)

25287 A METHOD FOR THE DETERMINATION OF THE S-MATRIX FOR SCATTERING BY A TENSOR POTENTIAL. J. R. Cox (Florida Atlantic Univ., Boca Raton) and A. Perlmutter. Nuovo Cimento (10), 37: 76-87(May 1, 1965).

The scattering of two spin one-half particles which are coupled by a tensor force is considered. The usual coupled second-order equations for the radial wave function are transformed into three coupled first-order equations for three real parameters whose asymptotic values determine the S-matrix. The usefulness of such a formulation for numerical computations of the S-matrix is illustrated by considering in detail several simple examples. (auth)

25288 POTENTIAL SCATTERING AND THE BARYON-MASS SPECTRUM. C. L. Hammer and T. A. Weber (Ames Lab., Ames, Iowa). Nuovo Cimento (10), 37: 88-103(May 1, 1965).

A mass spectrum of the form $m^2 = M_l(M_l + |\alpha_l|)$ is derived, where α_l is the imaginary part of the l-th singularity in the complex energy plane of a T-matrix which describes the interaction of a particle of initial rest mass m with a potential $V(x,t)$, where $V(x,t) = 0$ in the limit $|t| \rightarrow \infty$. The same mass formula, with α_l replaced by $(\alpha_l/2)$, is obtained for two particles, each of initial rest mass m, interacting via the potential $V(x,t)$ where here x is the relative distance between the particles. This spectrum is found to give, within 1%, the mass of all baryons less than or equal to the mass of the Ω^- if m is taken as 1747 Mev and α_l (or $\alpha_l/2$) is a small integral multiple of the K and π meson masses. Comparison to the Gell-Mann-Okubo formula relates these integers to the hypercharge and the isotopic spin. (auth)

25289 SEARCH FOR THE Z^+-BARYON. E. H. Bellamy, T. F. Buckley, P. V. March, et al. (London Univ.). Nuovo Cimento (10), 37: 110-13(May 1, 1965).

A search was made for the production of Z^+ baryons of mass 1370 Mev in the reaction $\pi^- + p \rightarrow K^- + Z^+$ at a pion momentum of 2.3 Bev/c, using spark chambers. No evidence for their existence was found. The upper limit to the differential cross section at zero degrees of the reaction investigated is estimated to be 50 μb/sr, or about 18 times smaller than might be expected on the basis of SU_3 invariance. (auth)

25290 THE ELECTROMAGNETIC RADIUS OF THE NEUTRINOS. L. F. Landovitz (Yeshiva Univ., New York). Nuovo Cimento (10), 37: 133-6(May 1, 1965).

The electromagnetic radius of the neutrino is calculated by use of dispersion relations. If an intermediate vector boson is used, $\langle x^2 \rangle = -6(g^2/2\pi^2)(1/3m_B^2)[\log(m_B^2/m_l^2) + (1/6)]$. If no intermediate vector boson is used, $\langle x^2 \rangle = -6(G/f)^2 (1/4\pi^2)(m_l^2/m)^2(1/3m_\pi^2[\log(m_\pi^2/m_l^2) - (1/3)]$. (auth)

25291 CABIBBO'S THEORY AND NEUTRINO-INDUCED REACTIONS. A. Sirlin (New York Univ., New York). Nuovo Cimento (10), 37: 137-41(May 1, 1965).

The differential cross sections for the reactions $\bar{\nu} + N \rightarrow Y + l^+$ are discussed in the framework of Cabibbo's theory, under the assumption that the $\Delta S = 0$ axial vector

current is of the first class under G conjugation. It is pointed out that detailed studies of the differential cross sections would permit, in principle, a test of the theory over a wide range of momentum transfers. Estimates for the probabilities of these reactions are given. (auth)

25292 PRODUCTION OF N^* IN NEUTRINO REACTIONS. C. W. Kim (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 37: 142-8(May 1, 1965).

The production cross section of the N^* pion-nucleon isobar in neutrino reactions is calculated. In order to determine the values of some of the form factors, the conserved vector current theory and the Goldberger-Treiman relation were used. The high-energy behavior of the total cross section is shown to depend rather sensitively on the high-momentum transfer behavior of the form factors. (auth)

25293 p-p SCATTERING AND A MODEL OF REGGEIZED INTERACTION. A. N. Mitra (Univ. of Delhi) and J. D. Anand. Nuovo Cimento (10), 37: 149-60(May 1, 1965).

The investigation was undertaken with a two-fold objective, to fit the high-energy p-p data at low and moderate momentum transfers with an exact Regge amplitude and to devise a model which could lead to such an amplitude by a crossing relation ($s \rightleftharpoons t$). A suitable choice of shapes for the Regge parameters $\alpha(t)$ and $\beta(t)$ in the exact amplitude so as to conform to certain standard requirements of analyticity and asymptotic behavior leads to rather good fits to the observed diffraction structures up to moderate momentum transfers. Next, a model of a Regge-type separable potential through a relativistic Schrödinger equation is constructed and found to give rise to an exact Regge amplitude without any background integral. However, the latter is unsuitable for scattering in the crossed channel, as the crossed amplitude ($s \rightleftharpoons t$) suffers from lack of proper analytic behavior. On the other hand, the model admits of a Khuri modification to reproduce proper threshold behavior in the direct channel, and leads exactly to a Khuri-Jones type amplitude which is fitted to singlet n-p scattering in s and d states. (auth)

25294 AN EXPLICIT SOLUTION OF THE BARGMAN-MICHEL-TELEGDI EQUATION FOR THE POLARIZATION IN A MAGNETIC FIELD. S. Ciccariello (Universita, Padua and INFN, Padua). Nuovo Cimento (10), 37: 161-5(May 1, 1965).

The general solution for the polarization of a particle in a uniform magnetic field is obtained. A relation which might simplify the experimental evaluation of the magnetic moment of the particles is considered. (auth)

25295 THE CONTRIBUTION OF MESON EXCHANGE TO THE α-α POTENTIAL. T. W. Preist (Brown Univ., Providence). Nuovo Cimento (10), 37: 166-71(May 1, 1965).

The graphs for the exchange of the ω meson and a neutral scalar meson σ are used to calculate the α-α potential. The phase shifts for this potential are compared with experiment and reasonable agreement is obtained using coupling constants similar to those used in nucleon-nucleon calculations. (auth)

25296 ON THE CONNECTION BETWEEN THE POINCARÉ GROUP AND INTERNAL SYMMETRY GROUPS. H. Caprasse and P. Jasselette (Universite, Liege). Nuovo Cimento (10), 37: 179-86(May 1, 1965).

Three new theorems are proved from which can be deduced that the conditions $[H_i, P_0] = [H_i, M_{ij}] = 0$ are maximal in the following sense: the vanishing of any supplementary set of commutators implies that the group obtained in combining the Poincaré group with an internal symmetry group reduces to a direct product. (auth)

25297 ω-ρ MIXING AND CHARGE-DEPENDENT EFFECTS IN THE SU_3 SCHEME. L. E. Picasso (Universita, Pisa, Italy), L. A. Radicati, D. P. Zanello, and J. J. Sakurai. Nuovo Cimento (10), 37: 187-98(May 1, 1965).

The ω-φ mixing model, previously introduced to provide a dynamical explanation of the breaking of the SU_3 symmetry for strong interactions, is extended by assuming a similar but weaker mixing between the ρ^0 meson and the SU_3-singlet component of the ω meson. Although this ω-ρ mixing is due to the electromagnetic interactions, it is treated in a phenomenological way. It is assumed that it gives an important contribution to the electromagnetic mass differences inside the SU_3 multiplets. Other electromagnetic effects cannot be completely neglected, but they are taken into account in a simple way. Then the model, based on both ω-φ and ω-ρ mixings, predicts for baryons and pseudoscalar mesons a number of sum rules whose agreement with the experimental data is quite encouraging. The model also predicts a decay rate for $\omega \rightarrow 2\pi$ in accordance within the errors with the experimental data. (auth)

25298 ON THE MINIMAL INTERNAL COUPLING. A. Kihlberg (Chalmers Univ. of Tech., Goteburg and CERN, Geneva). Nuovo Cimento (10), 37: 217-24(May 1, 1965).

An attempt is made to examine under what conditions the minimal internal coupling between the inhomogeneous Lorentz group and an internal symmetry group arises naturally. An answer is given to the question of whether the momenta in an irreducible representation can be diagonalized when the internal symmetry group is compact. (auth)

25299 A THEORY OF ELEMENTARY PARTICLES. C. Lovelace (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 37: 225-65(May 1, 1965).

We explore what happens if the four leptons are allowed to form a quartet, instead of being chopped up to make a triplet. If one also requires SU_3 invariance for the baryons, one is led very naturally to the third-rank group B_3. The third quantum number, L = leptocharge, is nonzero only for leptons among known particles. It also cancels fractional charge for SU_3 triplets. Leptons and antileptons form an 8-fold massless representation. When B_3 is broken down to SU_3, only the muon is allowed a mass. Preferred assignments for baryons, mesons, and vector mesons are $\{21\}$, $\{27\}$ and $\{21\}$, respectively. Yukawa coupling is then pure D, and there are no unwanted selection rules. $\{21\}$ and $\{27\}$ each contain an SU_3 octet and singlet of normal particles (L = 0), together with triplets or sextuplets of leptobars. The latter are strongly interacting particles with the quantum numbers of a baryon (or meson) +2 leptons. If the symmetry is broken by an L = 3 boson (M^{2+}), this explains the muon mass, and makes the leptobars much heavier than normal baryons, while preserving SU_3. The M^{2+} would decay strongly into $2\mu^+$. Tables of the structure of B_3 representations up to $\{448\}$, and techniques which should be useful in other big groups are given. (auth)

25300 THE ANALYTIC PROPERTIES OF REGGE TRAJECTORIES. PART II. A. E. A. Warburton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nuovo Cimento (10), 37: 266-77(May 1, 1965).

The branch points of the Regge trajectories $\alpha(k)$ are studied for varying strength A of a Yukawa potential, both attractive and repulsive. They go to $k = 0$ for $A \rightarrow 0$, while for large A they go to infinity as $A^{\frac{1}{2}}$, or leave the physical sheet. For attractive potentials, the branch points leave the physical k^2 sheet for A of order unity. Those trajectories which tend to complex l_0 as $k \rightarrow 0$ are also discussed. As an example of a more complicated potential with relativistic-looking trajectories, α-α scattering is considered. (auth)

25301 ON THE THEORY OF PION PRODUCTION. F. Selleri (Cornell Univ., Ithaca, N. Y.). Nuovo Cimento (10), 37: 278-300(May 1, 1965).

The matrix element and the cross section for single-pion production in pion-nucleon collisions are expressed in terms of four scalar invariant amplitudes. The contributions to these amplitudes from the nearest singularities in the t and u channels for $T = J = \frac{3}{2}$ isobar production and from the nucleon pole of the s-channel are calculated. Pion-pion scattering is also included. Full account is taken of the virtuality of the different intermèdiate states. The model provides a natural explanation of the 1512-Mev D_{13} resonance, which should be accompanied by a P_{11} resonance at roughly the same energy. (auth)

25302 A RELATIVISTIC GENERALIZATION OF THE SU_6 SYMMETRY GROUP. W. Ruehl (CERN, Geneva). Nuovo Cimento (10), 37: 301-18(May 1, 1965).

Two different inhomogeneous versions of SL(6, C) are studied. A discussion of the representations of these groups is given, and the possibility of introducing a parity transformation and of constructing currents which conserve the transversality of a field coupled to them is considered. (auth)

25303 BARYONS AND MESONS AND THEIR COUPLING IN A THEORY WHICH COMBINES RELATIVISTIC INVARIANCE WITH SU_6 SYMMETRY. W. Ruehl (CERN, Geneva). Nuovo Cimento (10), 37: 319-32(May 1, 1965).

The representations of baryons and mesons according to a group which generalizes SU_6 relativistically are discussed. By means of these representations invariant couplings are constructed. These couplings allow for arbitrary recoils. In the static limit of the baryon-baryon + meson channel the results are identical with those known from the nonrelativistic SU_6 model. Because crossing symmetry holds in the model these results apply to the baryon + antibaryon-meson channel. (auth)

25304 SYMMETRIES AND COMPOSITENESS. PART II. J. S. Dowker and P. A. Cook (Univ. of Manchester, Eng.). Nuovo Cimento (10), 37: 336-7(May 1, 1965).

It is shown that the matrix compositeness conditions $Z_3 = 0$ and $Z_1 = 0$ lead to SU_n invariance and also relate the multiplicities of the various particles. (C.E.S.)

25305 ELECTROMAGNETIC MASS CORRECTIONS IN THE COVARIANT SV_{12} SCHEME. P. Roman and J. J. Aghassi (Boston Univ.). Nuovo Cimento (10), 37: 354-7 (May 1, 1965).

The full symmetry group, denoted by SV_{12}, which has the same Lie algebra as SU_{12} but is noncompact, is discussed. The SV_{12} group is intrinsically broken into $L_5 \otimes SU_3$, where L_5 stands for the de Sitter group and has the algebra of O(5). Electromagnetic mass corrections are obtained. (C.E.S.)

25306 π-π INTERACTIONS IN $\pi^+p \to n\pi\pi$ REACTIONS AT 2.75 Gev/c. N. Armenise (Universita, Bari, Italy), B. Ghidini, S. Mongelli, et al. Nuovo Cimento (10), 37: 361-75 (May 16, 1965).

A total of 16,000 two-prong events in π^+p interactions at 2.75 Bev/c in the Saclay HBC 81 cm irradiated at C.E.R.N. were analyzed. Results concerning ρ^+ production in reactions $\pi^+p \to p\rho^+$ (σ = (0.89 ± 0.10) mb) and $\pi^+\pi^+$ system in reaction $\pi^+p \to n\pi^+\pi^+$ are presented. For these reactions the OPE model is dominant. These shift analyses of $\pi^+\pi^+$ (T = 2) scattering were performed, and the contributions of S and D waves were studied as functions of the di-pion mass. (auth)

25307 ONE-VARIABLE DISPERSION RELATIONS. A. Minguzzi (Universita, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 37: 390-5(May 16, 1965).

It is shown that the analyticity properties of the scattering amplitude in the energy which have been proved previously hold more generally when no restrictions are imposed on the asymptotic behavior of the amplitude. (auth)

25308 "TARGET MASS" AND "EFFECTIVE TARGET MASS." M. F. Kaplon and M. L. Shen (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 37: 423-9(May 16, 1965).

The concept of target mass and effective target mass is discussed. Evidence is presented which questions the validity of attempting to relate the effective target mass to the concept of a virtual pion surrounding the nucleon. Relations between the 4-momentum transfer, the quantity $(E - P \cos \theta)$ of the recoil nucleon and the effective target mass are derived which show in conjunction with experimental data that the effective target mass of the order of a pion mass occurs accidentally. (auth)

25309 LARGE SPIN PROPAGATORS AND THEIR AMBIGUITY. G. Mohan and S. C. Agarwal (National Physical Lab., New Delhi, India). Nuovo Cimento (10), 37: 430-9(May 16, 1965).

The undetermined coefficients in the propagators of particles of spin greater than unity were related to the coupling constants with top-level Regge trajectories exchanged. Propagators for particles of some higher spins were listed, and a simple method of obtaining large spin propagators is outlined. (auth)

25310 SYMMETRIC SPINOR THEORY FOR ANY SPIN. D. L. Weaver (Tufts Univ., Medford, Mass.) and D. M. Fradkin. Nuovo Cimento (10), 37: 440-9(May 16, 1965).

A manifestly covariant theory for a particle with any integer or half-integer spin is given as differential equations relating two symmetric spinors. The plane-wave solutions are exhibited in a form directly applicable to calculations involving high-spin particles. The continuity equation, for the conserved quantities corresponding to both the continuous and discontinuous, covariant transformations of the system is derived for any spin. Application of the theory is made to spin ½ and spin one. (auth)

25311 ON THE NUMBER OF BOUND STATES OF A THREE-PARTICLE SYSTEM. G. C. Ghirardi and A. Rimini (Universita, Trieste, Italy). Nuovo Cimento (10), 37: 450-4(May 16, 1965).

The problem of deriving upper bounds to the number of bound states of a three-particle system with two-body interactions is considered. Under very general assumptions about the two-body forces, explicit upper bounds are obtained for the number of bound states lying below a chosen energy value. Such bounds are given in terms of the interactions, of the free and the two-body Green functions. It is shown that is is possible to get rid of the two-body Green functions obtaining formulas of practical use. (auth)

25312 SELECTION RULES IN WEAK INTERACTION. N. N. Biswas (Max-Planck-Institut fur Physik and Astrophysik, Munich). Nuovo Cimento (10), 37: 455-62(May 16, 1965).

An attempt is made to account for the selection rules in weak interaction processes; it is assumed that the currents of all possible strangenesses are present and are represented by four-component spinors. The coupling between the currents to give rise to interaction is made by projecting out the singly charged components, and it is found that the strangeness selection rules work satisfactorily, at least in the lowest order. Further, assigning the lowest possible isospin to the currents, the isospin selection rules are also satisfactory; in particular, the $|\Delta I| = ½$ transition seems to be quantitatively accounted for. (auth)

25313 ON THE COMPUTATION OF THE MANY-CHANNEL S-MATRIX. J. R. Cox (Florida Atlantic Univ., Boca Raton, Fla.). Nuovo Cimento (10), 37: 474-91(May 16, 1965).

The n-channel s-wave radial Schrödinger equation is transformed into a Riccati equation for a matrix function S(K,r) which approaches the S-matrix asymptotically as $r \to \infty$. It is pointed out that under rather general conditions, S(K,r) is completely determined by a single function f(K,r) which approaches the Fredholm determinant as $r \to \infty$. The problem of parametrization of S(K,r) is briefly discussed, and by making use of the algebraic relations between S(K,r) and f(K,r), the two-channel problem is reduced to the solution of three coupled first-order equations for three real bounded parameters which determine the S-matrix. These equations are especially convenient for numerical computations. (auth)

25314 THE N/D METHOD IN POTENTIAL SCATTERING. E. M. Nyman (NORDITA, Copenhagen). Nuovo Cimento (10), 37: 492-9(May 16, 1965).

The Chew-Mandelstam procedure of constructing the partial-wave scattering amplitude from analytic properties and unitarity is investigated in nonrelativistic potential scattering. The left-hand discontinuity is kept to lowest order in the strength of the interaction. It is shown that the existence of a bound-state pole in the scattering amplitude implies the existence of a ghost state for the corresponding

potential with the opposite sign of the strength. The role of the subtraction point when the scattering amplitude is constructed by an iterative method is discussed. Numerical results for the Yukawa potential are given and compared with the corresponding quantities obtained from the Schrödinger equation. (auth)

25315 MESON PRODUCTION BY NEUTRINOS INCIDENT ON NUCLEONS. G. R. Henry and M. Veltman (CERN, Geneva). Nuovo Cimento (10), 37: 500-10(May 16, 1965).

Production and exchange of nonstrange pseudoscalar and vector mesons are considered in the peripheral model. For nonstrange mesons a consequence of this model is that the corresponding ν and $\bar{\nu}$ cross sections are equal, assuming that ν and $\bar{\nu}$ couple to the same isospin multiplet. The cross section for production of ρ and ω with π exchange, with and without simultaneous excitation of the $3/2$, $3/2$ resonance, is found to be a fraction (with strong dependence on badly known form factors) of the elastic cross section, $\sigma(\nu + n \rightarrow p + \mu^-)$, at a few Bev incident-neutrino energy. Production of π and η mesons with ρ and ω exchange is computed also, and is found to be very small. (auth)

25316 NUMERICAL SOLUTION OF A SIMPLIFIED BETHE-SALPETER EQUATION FOR PION-PION INTERACTION NEAR t = 0. M. Restignoli, L. Sertorio, and M. Toller (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 37: 511-23(May 16, 1965).

The Bethe-Salpeter equation for two pions interacting through the exchange of ρ mesons is investigated in the ladder approximation. The form factor of the π-ρ-π vertex is taken into account by means of a simple expression containing an adjustable parameter. The equation for zero-energy Regge poles is solved numerically and a perturbative method is used to find the slope of the Regge trajectories. (auth)

25317 PHENOMENOLOGICAL DESCRIPTION OF THE RELATIVISTIC NEUTRON-PROTON-DEUTERIUM VERTEX. M. Gourdin, M. le Bellac, F. M. Renard, and J. Tran Thanh Van (Universite de Paris, Orsay, France). Nuovo Cimento (10), 37: 524-42(May 16, 1965).

A phenomenological study of the neutron-proton-deuterium relativistic vertex functions is presented. The covariant dispersion relation approach is used to define relativistic wave functions and to obtain various sum rules on the spectral functions. The results are compared with experiment. (C.E.S.)

25318 GROUP-THEORETICAL BASIS OF THE ANGULAR MOMENTUM HELMHOLTZ THEOREM OF LOMONT AND MOSES. H. Leutwyler (Universitat, Bern). Nuovo Cimento (10), 37: 543-55(May 16, 1965).

It is shown that the first part of the angular momentum Helmholtz theorem—the part which is relevant for the applications—is of purely group-theoretical nature and is valid for a large class of Lie groups. (auth)

25319 A NO-INTERACTION THEOREM IN CLASSICAL RELATIVISTIC HAMILTONIAN PARTICLE MECHANICS. H. Leutwyler (Universitat, Bern). Nuovo Cimento (10), 37: 556-67(May 16, 1965).

It is shown that a nondegenerate hamiltonian theory of a finite number of classical particles cannot describe any interaction if the theory is relativistically invariant and if the co-ordinates of the particles transform correctly under the inhomogeneous Lorentz group. (auth)

25320 HIGHER-ORDER BOSON-LEPTON WEAK INTERACTIONS IN THE LADDER GRAPHS APPROXIMATION. S. Badier and C. Bouchiat (Universite de Paris, Orsay, France). Nuovo Cimento (10), 37: 568-88(May 16, 1965).

An attempt is made to extend the peratization theory of Feinberg and Pais to the case of boson-lepton reactions and to determine the effective meson(π)-lepton effective coupling constant. It was found that the effective coupling constant is not $3/4(g^2/m^2)$ as in the fermion-fermion case, but instead $9/8(g^2/m^2)$, which is in contradiction with experiment. Although the comparison is made on a particular subset of graphs neglecting the strong-interaction radiative corrections one should expect to meet with difficulties if one wants to keep the predictions of the conserved vector current in a theory where higher order effects are important. The selection rules associated with lowest-order diagrams remain valid in this model. (C.E.S.)

25321 BOUND STATES AND REGGE TRAJECTORIES IN A VECTOR MESON EXCHANGE MODEL. II. THE $N\bar{N}$ SYSTEM BOOTSTRAP. R. C. Arnold (Univ. of California, Los Angeles). Nuovo Cimento (10), 37: 589-607(May 16, 1965).

A study of bound states of nucleon-antinucleon pairs is carried out with an unsubtracted N/D method previously applied to the $K\bar{K}$ system. The binding forces are generated by meson exchanges treated with Regge pole formalism. The meson exchange terms are chosen to be consistent with fits to nucleon-nucleon scattering data. It is shown that π, η, ρ, and ω mesons may be obtained as bound $N\bar{N}$ states, but predictions are limited in detail because of sensitivity to input Regge slope parameter values. A discussion of self-consistency is given, and the bootstrap mechanism for the mesons is found to be not completely consistent when only $N\bar{N}$ states are included. (auth)

25322 A TWO-PARTICLE MODEL FOR HIGH-ENERGY COLLISIONS. A. Bialas, Th. W. Ruijgrok, and L. Van Hove (CERN, Geneva). Nuovo Cimento (10), 37: 608-30(May 16, 1965).

A very simplified model of high-energy collisions of strongly interacting particles is investigated. It introduces two particles A and B, where A can be regarded as stable and B as an unstable resonance of A. It assumes that all high-energy collisions can be described as taking place between the three channels A + A, A + B, and B + B, so that the S-matrix is 3×3. Taking further A and B to be self-conjugate, it enables one to express all consequences of crossing symmetry in terms of the nine S-matrix elements. From these crossing relations and from unitarity it is shown that for each orbital momentum l the S-matrix depends on a single real parameter a_l which has a simple physical significance in terms of the K-matrix. Constant high-energy cross-sections are obtained when a_l is a function $a(\rho)$ of the impact parameter. When $a(\rho)$ is a smoothly decreasing function of ρ approaching zero for $\rho \rightarrow \infty$ more rapidly than any power of ρ^{-1}, and has moderately large values for small ρ, one finds that the elastic differential cross sections derived from the model agree with the experimental shape of the diffraction peak and are insensitive to the detailed form of $a(\rho)$. If $a(\rho)$ is very large for all ρ for which it does not vanish the elastic angular distributions become of the black sphere type. This insensitivity is due to the strong damping imposed by unitarity of the S-matrix whenever the K-matrix elements are appreciable. (auth)

25323 THREE-DIMENSIONAL LORENTZ GROUP AND HARMONIC ANALYSIS OF THE SCATTERING AMPLITUDE. M. Toller (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 37: 631-57(May 16, 1965).

The many-particle scattering amplitude is projected on the matrix elements of the unitary irreducible representations of the three-dimensional Lorentz group. The usefulness of this transformation in the treatment of a certain class of integral equations satisfied by the amplitude is pointed out. A generalization taking into account a set of nonunitary representations is shown to lead to a transformation which has many of the properties of the classical Laplace transformation and can be used to obtain asymptotic expansions similar to those obtained from the Watson-Sommerfeld formula. (auth)

25324 OPTICAL MODEL AND ANALITICITY IN MOMENTUM TRANSFER. K. Chadan (Universite de Paris, Orsay, France). Nuovo Cimento (10), 37: 658-63 (May 16, 1965).

It is shown that in the Omnès method of calculating the optical potential from the scattering amplitude at high energies the requirement of Mandelstam analyticity in cos θ-plane can be replaced by that of analyticity inside an ellipse. (auth)

25325 SUM RULES FOR LEPTONIC DECAYS. E. Kazes (Pennsylvania State Univ., Univ. Park). Nuovo Cimento (10), 37: 664-6(May 16, 1965).

As a consequence of SU_3 breaking interactions it is assumed that the hadronic current of leptonic decay acquires a part that transforms as $\left(\frac{1}{2},\frac{1}{2}\right)$. This leads to various relations among the different leptonic decay (or reaction) amplitudes of the baryon octet. (auth)

25326 REGGE POLES NEAR THE THRESHOLDS IN MULTI-CHANNEL PROBLEMS. Y. N. Srivastava (Univ. of California, Riverside, Calif.). Nuovo Cimento (10), 37: 667-70(May 16, 1965).

The infinitely many poles that converge to the point $l = -\frac{1}{2}$ at the threshold of elastic scattering are studied for coupled channels. It is shown that they exist at all thresholds for every S-matrix element. In addition, it is found that these threshold poles are responsible towards producing some extra zeros in the amplitude. (auth)

25327 MINIMAL INTERACTIONS AT VERY HIGH TRANSFERS. A. Martin (CERN, Geneva). Nuovo Cimento (10), 37: 671-84(May 16, 1965).

It is shown that both large-transfer electron-proton scattering and large-angle proton-proton scattering may be consistent with, or close to, the lower limits obtained from dispersion theory. For form factors the fastest allowed decrease is $\exp[-\sqrt{|q^2|}]$, where q is the four-momentum transfer of the photon. For scattering amplitudes one gets $\exp[-C(\theta)\sqrt{s}]$ or $\exp[-C(\theta)\sqrt{s}\log s]$ or $\exp[-C(\theta)\sqrt{s}(\log s)^2]$ according to various detailed assumptions, where s is the square of the c.m. energy and θ the c.m. scattering angle. The conditions to impose on the growth of the form factors and the scattering amplitude outside the physical region to obtain these results are considerably weaker than the usual polynomial boundedness condition, and are likely to be satisfied by the actual form factors or scattering amplitudes. (auth)

25328 ABSORPTIVE EFFECTS IN PERIPHERAL PRODUCTION PROCESSES: THE REACTION $\pi^+p \rightarrow \omega A^{++}$. B. E. Y. Svensson (CERN, Geneva). Nuovo Cimento (10), 37: 714-25(May 16, 1965).

Calculations are reported on the reaction $\pi^+p \rightarrow \omega A^{++}$, followed by the decays $\omega \rightarrow \pi^+\pi^0\pi^-$ and $A^{++} \rightarrow \pi^+p$, using the model of Gottfried and Jackson in which the one-meson-exchange model, in this case ρ-exchange, is modified to take into account absorption in the initial and final state due to competition from other open channels. It is shown that the suppression of the low partial waves introduced by this model changes the predicted decay distributions significantly to be in rough agreement with the experimental data. (auth)

25329 ON A METHOD FOR DETERMINING THE NEUTRETTO MASS. E. S. Ginsberg (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 37: 739-44(May 16, 1965).

The proposal to obtain a limit on the neutretto mass from an observation of the high-energy end of the spectrum of one particle in a three-body decay of the type $A \rightarrow B + C + \nu$ is re-examined and an expression contained in the literature is corrected. Energy spectra for radiative pion decay are given as an illustration. Numerical results are presented for the decays $\pi^+ \rightarrow \mu^+ + \nu + \gamma$, $\Lambda \rightarrow p + \mu^- + \nu$ and $K^+ \rightarrow \pi^0 + \mu^+ + \nu$. (auth)

25330 SUM RULES FOR NONLEPTONIC WEAK GAMMA-DECAYS OF BARYONS. Shui-Yin Lo (Univ. of Chicago). Nuovo Cimento (10), 37: 753-5(May 16, 1965).

An analysis is made of the the strangeness-changing but charge-retaining weak gamma decays ($\Delta S = 1$, $\Delta Q = 0$) $B_1 \rightarrow B_2 + \gamma$. It is assumed that the weak interaction is CP invariant, the weak spurion transforms like a number of a unitary octet, and the strangeness-changing part of this weak spurion is the sixth component of a unitary octet. (C.E.S.)

25331 A SIMPLE APPROXIMATION FOR THE SCATTERING LENGTH PRODUCED BY REPULSIVE POTENTIALS STRONGLY SINGULAR IN THE ORIGIN. F. Calogero (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 37: 756-9(May 16, 1965).

The problem of scattering on central potentials that are more singular in the origin than the centrifugal term and are repulsive in that neighborhood is considered. An approximate expression is proposed for the scattering length in the simple case of S-wave zero-energy scattering. Only repulsive interactions are considered. (C.E.S.)

25332 EXPONENTIALLY SINGULAR POTENTIALS AND PERATIZATION. F. Calogero and M. Cassandro (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 37: 760-4(May 16, 1965).

The scattering length associated with the potential $V(r) = r^{-4}[g \exp(2/r) + g']$ and an explicit application of peratization in the coupling constant g for g' fixed are discussed. The results obtained are compared with previous results. (C.E.S.)

25333 WIGNER'S SUPERMULTIPLET THEORY IN THE SU_6 FRAMEWORK. G. Cicogna (Scuola Normale Superiore, Pisa, Italy), E. Fabri, and L. E. Picasso. Nuovo Cimento (10), 37: 765-6(May 16, 1965).

It was previously shown that SU_6 contains a subgroup $SU_4(T)$ isomorphic to SU_4. By classifying the 56 baryons according to this group (denoted by T) it was found that N, N* belong to a 20-dimensional representation of it, and that, as far as only these states are concerned, T contains the spin and isospin generators just as in the usual Wigner's supermultiplet theory. An attempt is made to reconcile this assignment of nucleons to a 20-dimensional representation with Wigner's assignment to the 4-dimensional representation of SU_4. (C.E.S.)

25334 THE SUBGROUP $SU_4(T) \otimes SU_2(X) \otimes W(Y)$ AND WEAK INTERACTIONS. F. Buccella (Universita, Florence), G. Martucci and R. Gatto. Nuovo Cimento (10), 37: 782-4(May 16, 1965).

The observation that the lepton currents satisfy a SU_2 algebra and the ensuing formulation of the notion of universality in terms of SU_2 commutation relations leads one to ask whether a suitable extension of the SU_2 subgroup of the strong interaction symmetry group is more relevant to the theory of weak interactions than the full symmetry. In view of the success of SU_6, an attempt is made to answer this question for the subgroup $SU_4(T) \otimes SU_2(X) \otimes W(Y)$ which provides for a suitable extension of the isospin group SU_2. It is found that no crucial evidence for the extension of the weak-current symmetry to the full group can be derived from semileptonic interactions. The restriction of the symmetry of nonleptonic interactions to the subgroup fails to account for possible relations between Ξ decay and Λ and Σ decay into nucleon plus a pion. The agreement with experiment of these particular relations is however rather rough. (C.E.S.)

25335 RELATIVISTIC MODEL WITH APPROXIMATE SU_6 SYMMETRY. L. E. Picasso (Universita, Pisa, Italy). Nuovo Cimento (10), 37: 785-7(May 16, 1965).

The exact nature and meaning of a spin and unitary spin independence of strong interactions not conflicting with relativistic invariance is considered. The point of view is taken that strong interactions are invariant under the Poincaré group and SU_2 and that an approximate SU_6 symmetry emerges dynamically. This idea is discussed in the frame of the quark model of Gell-Mann. (C.E.S.)

25336 FURTHER TESTS OF THE VIOLATION OF CP WITH NEUTRAL K MESONS. R. R. Lewis (Univ. of Michigan, Ann Arbor and Universite, Geneva) and C. P. Enz. Phys. Letters, 16: 73-5(May 1, 1965).

The possibility of determining the additional parameters in the total mass matrix, irrespective of any specific assumptions about the machanism of CP violation, is considered. Three experiments are proposed for testing T and TCP and for measuring the magnitude and phase of the CP admixture: measurement of the total intensity of a neutral kaon beam versus the distance from the production vertex of a K meson; measuring the relative intensity of any partial decay in a beam of neutral kaons in which a K or a $\overline{K}$ is initially produced; and cancelling the intrinsic CP admixture in K_S, K_L, by the induced CP admixture resulting from coherent scattering in a regenerator. (L.B.S.)

25337 A POSSIBLE Y = 2, S = 0, $pp\pi^+$ RESONANCE AT 2520 Mev. J. Kidd (Istituto Nazionale di Fisica Nucleare, Milan), L. Mandelli, V. Pelosi, S. Ratti, A. Sichirollo, L. Tallone, F. Conte, and G. Tomasini. Phys. Letters, 16: 75-8(May 1, 1965).

Evidence obtained from a systematic study of pp interactions at 4 Bev/c from the Saclay hydrogen bubble chamber exposed to the CERN proton synchrotron is presented, which can be interpreted as indication of a $pp\pi^+$ resonance at 2520 Mev, with a full width of about 120 Mev. Effective mass distributions were obtained from an analysis of the $p + p \rightarrow p + p + \pi^+ + \pi^-$ reaction and are compared with predictions of the statistical model, the isobar model, and the one pion exchange model. It is concluded that if the evidence is interpreted as a $pp\pi^+$ resonance the characteristics of the resonance are in agreement with the prediction of the SU(6) model by Dyson and Xuong. (L.B.S.)

25338 IONIZATION LOSS OF RELATIVISTIC MUONS. F. Ashton and D. A. Simpson (Univ. of Durham, Eng.). Phys. Letters, 16: 78-80(May 1, 1965).

An experiment was performed to study the energy loss of muons $\gg$ 8 Bev in an organic scintillator consisting of liquid phosphor of paraffin oil with p-terphenyl and POPOP as solutes. Calculations were made of the variation of the most probable energy loss of muons with momentum and are compared with experimental results. The results confirm the existence of the density effect to the highest momenta measured by no evidence was found for a decrease of energy loss at high energy as suggested by Tsytovich. (L.B.S.)

25339 BRANCHING RATIOS OF K_2^0 DECAYS. P. Astbury (CERN, Geneva), G. Finocchiaro, R. D. Fortune, A. Michelini, C. Verkerk, C. H. West, W. Beusch, M. Pepin, and M. A. Pouchon. Phys. Letters, 16: 80-3(May 1, 1965).

A π^- beam of 1.063 ± 0.038 Bev/c momentum, produced at the CERN proton synchrotron, was focused on a 2-m long H_2 target, and the momentum spectra of the K_2^0 from the reactions $\pi^- + p \rightarrow \Lambda^0 + K^0$ and $\pi^- + p \rightarrow \Sigma^0 + K^0$ decaying inside the chamber were calculated using previously published values of the cross sections. The events were analyzed using the CERN THRESH and GRIND programs, and ten possible decay schemes were obtained. Monte Carlo events, generated according to phase space and to the K_2^0 calculated spectra, were analyzed in the same manner as the experimental ones, and results of the transition rates for the $\pi^+\pi^-\pi^0$, $\pi^\pm\mu^\pm\nu$, and $\pi^\pm e^\pm\nu$ modes were obtained. (L.B.S.)

25340 THE K^+-PROTON INTERACTION AT 1.45 Gev/c. A. Bettini (Universita, Padua and Istituto Nazionale di Fisica Nucleare, Padua), M. Cresti, S. Limentani, L. Peruzzo, R. Santangelo, D. Locke, D. J. Crennell, W. T. Davies, and P. B. Jones. Phys. Letters, 16: 83-6(May 1, 1965).

The CERN 32-cm hydrogen bubble chamber was exposed to a separated K^+ beam of momentum 1.45 Bev/c, and the single production of pions was studied with special reference to the one meson exchange model. The 890-Mev K^* and the 1220-Mev N^* were strongly produced, and their differential cross sections are presented. The contributions of vector and pseudoscalar exchange processes to the K^* production cross section is determined. The cross sections at 1.45 and 3.0 Bev/c are compared, and it is concluded that if the production of the K^* and N^* states is to be described by the one meson exchange model, the form factors which appear in the model cannot be functions of the invariant momentum transfer alone, but must also be functions of the total center of mass. (L.B.S.)

25341 THE REGGE RECURRENCE OF THE POMERANCHUK TRAJECTORY AS A MEMBER OF A UNITARY OCTET OF SPIN 2 MESONS. G. A. Ringland and E. J. Squires (Univ. of Durham, Eng.). Phys. Letters, 16: 86-7 (May 1, 1965).

The implications of the f^0 meson as a member of a unitary octet of $J^P = 2^+$ mesons, each of which are associated with a Regge trajectory, are discussed. (L.B.S.)

25342 ON A DIFFICULTY IN CONSTRUCTING COMBINED INVARIANCE THEORIES. R. Mirman (Long Island Univ., Brooklyn). Phys. Letters, 16: 88(May 1, 1965).

It is shown that if the Lorentz algebra, consisting of the homogeneous operators M_θ and the translation operators P_μ, is imbedded in a semisimple algebra with mutually commuting operators H_i and step operators E_γ, at least one of the H_i does not commute with the P_μ, and with the mass squared operator. (L.B.S.)

25343 THE INTERACTIONS OF LOW-ENERGY K^- MESONS WITH PROTONS. M. Csejthey-Barth (Universite Libre, Brussels), J. P. Lagnaux, J. Sacton, et al. Phys. Letters, 16: 89-91(May 1, 1965).

Two stacks of Ilford emulsion were exposed at the CERN proton synchrotron to low-energy K^- mesons, and the K^--p elastic scattering cross section as well as the ratio of the cross sections for the processes $K^- + p \rightarrow \Sigma^- + \pi^+$ and $K^- + p \rightarrow \Sigma^+ + \pi^-$ were measured at 50 to 200 Mev/c. The data are tabulated and compared with predictions of s-wave zero effective range solutions. (L.B.S.)

25344 A REMARK ON MAGNETIC MOMENTS IN THE SU_4 SUPERMULTIPLET MODEL. L. C. Biedenharn, J. Nuyts, and N. Straumann (CERN, Geneva). Phys. Letters, 16: 92-3(May 1, 1965).

The uniqueness of the magnetic moment and charge operators are examined, and it is pointed out that the SU(4) supermultiplet scheme of Leung and Barut lacks the uniqueness which characterizes the magnetic moment predictions for the nucleons in SU(6). (L.B.S.)

25345 RARE DECAYS OF THE A_2 MESON AND THE POSSIBLE EXISTENCE OF A SCALAR OCTET. E. Ferrari (CERN, Geneva). Phys. Letters, 16: 93-5(May 1, 1965).

Experimental investigations of the decays of the A_2 meson are reviewed, and the existence of a scalar octet containing the σ, κ, and δ mesons is discussed. An explanation of the experimental situation is provided on the basis of the validity of the Gell-Mann-Okubo formula for the mass of the δ meson, and the $K\overline{K}$ and $\pi\eta$ decays observed in the A_2 mass region are attributed to a O^{+-}-δ meson of nearly the same mass and width as the A_2. It is noted that for such a meson the two decay modes are the only strong modes which are possible, apart from the decay into five pions. (L.B.S.)

25346 $\tilde{U}(12)$ SYMMETRY AND THE JOHNSON-TREIMAN RELATIONS. J. M. Charap and P. T. Matthews (Imperial Coll. of Science and Tech., London). Phys. Letters, 16: 95-6(May 1, 1965).

It is pointed out that the inclusion of irregular amplitudes in either SL(6c) or U(12) vitiates the argument used by Blankenbecker et al. to exclude certain polarizations, since the required type of interference may occur between regular and irregular amplitudes. The regular and irregular forward scattering amplitudes are considered in U(12) theory, and it is found that the relevant parts of each of the twelve amplitudes that contributes to $\sigma(M) - \sigma(\overline{M})$ has the form of pure F-type baryon current coupled to the pure F meson current, where $\sigma(M)$ is the total cross section of mesons on protons. It is concluded that each term separately satisfies the Johnson-Treiman relations, which therefore remains valid in general in the theory. (L.B.S.)

25347 MEASUREMENT OF CROSS SECTIONS WITH NEUTRONS AS TARGETS. M. Widgoff Shapiro (Brown

Univ., Providence), A. M. Cormack, and A. M. Koehler. Phys. Rev., 138: B823-30(May 24, 1965).

The purpose of the experiment described was to test the use of the Chew-Low extrapolation technique for the measurement of cross sections with unstable particles as targets. The test was performed by using the Chew-Low method to measure proton-neutron total cross sections σ_{pn} with protons of 161-Mev energy incident on deuterium, and comparing the results thus obtained with values of the neutron-proton cross section previously determined from the scattering of projectile neutrons on hydrogen targets. At two values of the effective incident energy, 125 and 168 Mev, the values found were $\sigma_{pn} = 42.9 \pm 5.6$ and $\sigma_{pn} = 40.9 \pm 5.9$ mb, respectively. These values are in sufficiently good agreement with the corresponding values of σ_{np}, particularly at the higher energy where the extrapolation distance is shorter, to give confidence in the Chew-Low method for the determination of unknown cross sections. (auth)

25348 ALPHA-PARTICLE CONTINUUM STATES. Paul Szydlik (Catholic Univ. of America, Washington) and Carl Werntz. Phys. Rev., 138: B866-75(May 24, 1965).

The two-channel collision matrix for the $t + p \rightleftharpoons {}^3He + n$ system is obtained by calculating the amplitudes for isotopic spin 0 and 1 for the scattering of a nucleon and an A = 3 nucleus and combining these amplitudes in the proper linear combinations. The isotopic-spin amplitudes are obtained by making a resonating-group approximation for the continuum wave functions. It is found that with an "equivalent" central potential representing the nucleon-nucleon force the theory predicts the existence of two isotopic spin-0 bound excited states. These states, a 0^+ and a 1^-, are related to two experimentally observed structures in the cross sections. The good agreement of the theoretical and experimental cross sections in an energy region above the experimental peaks is used to establish the semiquantitative correctness of the pure isotopic-spin amplitudes obtained. (auth)

25349 PRACTICAL APPROXIMATION TO THE FADDEEV EQUATIONS. Jean-Louis Basdevant (Univ. of California, Berkeley). Phys. Rev., 138: B892-5(May 24, 1965). (UCRL-11838)

The form of the equations given by Faddeev for the problem of three-particle scattering is analyzed in the case in which the amplitudes of the two-body sub-systems are dominated by a finite number of pole terms. It is shown that an important simplification can be made, reducing the Faddeev equations to a system of coupled integral equations in one variable only. (auth)

25350 π^+p INTERACTIONS AT 4 Gev/c. Phys. Rev., 138: B897-912(May 24, 1965).

In photographs taken with the Saclay 81-cm hydrogen bubble chamber at the CERN proton synchrotron about 16,000 π^+p scatterings at 4 Bev/c with two and four charged secondaries were analyzed and identified. The cross sections for the individual two- and four-prong channels and for the production of resonances are given. The various effective-mass distributions are shown. The reaction $\pi^+p \rightarrow p\pi^+\pi^0$ is dominated by N^{*++} and ρ^+ production. From the reaction $\pi^+p \rightarrow n\pi^+\pi^+$ the T = 2 $\pi\pi$ cross section as a function of the energy was deduced applying the Chew-Low and the Selleri formula. The $\pi\pi$ angular distribution is isotropic (s wave) up to ~800 Mev. In the reaction $\pi^+p \rightarrow p\pi^+(m\pi^0)$ the N^{*++} and the A_2^+ occur. An estimate of the decay ratio $A_2 \rightarrow \eta\pi/A_2 \rightarrow \rho\pi$ yielded 0.3 ± 0.2. About 75% of the reactions $\pi^+p \rightarrow p\pi^+\pi^+\pi^-$ proceed via N^{*++} and ρ^0 production. The major features of this reaction can be explained by the one-pion-exchange (OPE) model; the various distributions were computed by a Monte Carlo method applying the Ferrari-Selleri off-shell corrections to the OPE formula. The experimental distributions can be reproduced rather well by the model. In the channel $\pi^+p \rightarrow N^{*++}\pi^+\pi^-$ the angular-momentum state of the $\pi^+\pi^-$ system has been studied. A highly pure sample of the reaction $\pi^+p \rightarrow N^{*++}\rho^0$ was obtained by limitation to small momentum transfers. A weak correlation between the N^{*++} and ρ^0 decay angles is observed. In the $\rho^0\pi^+$ effective-mass distribution the A_1 and A_2 show up. The A_1 and A_2 have a different Δ^2 and decay angular distribution; the A_1 enhancement can perhaps be explained by the OPE model. In the $p\pi^+\pi^-$ effective-mass distribution the T = 1/2 isobars at 1518 and 1688 Mev show up; there is no definite enhancement in the $p\pi^+\pi^+$ mass distribution. From the reactions $\pi^+p \rightarrow p\pi^+\pi^+\pi^-\pi^0$ a highly pure sample of the channel $\pi^+p \rightarrow N^{*++}\omega^0$ could be obtained by limitation to small Δ^2. The B meson is present in the $\omega^0\pi^+$ mass distribution; no definite conclusion for the spin and parity of the B meson could be reached. The previously observed enhancement at 975 Mev in the $\rho\pi$ mass distribution is discussed further. In the reaction $\pi^+p \rightarrow n\pi^+\pi^+\pi^+\pi^-$ and in the four-prong reactions with several neutrals there is no strong resonance production except for a slight amount of N^* and ρ. Finally the Δ^2 distributions for six two-body reactions (elastic scattering and five channels with resonance production) are given and compared with each other. In all distributions a small accumulation of events at high Δ^2 is observed besides the strong peak at small Δ^2. (auth)

25351 TOTAL CROSS SECTIONS OF PROTONS, ANTIPROTONS, AND π AND K MESONS ON HYDROGEN AND DEUTERIUM IN THE MOMENTUM RANGE 6-22 Gev/c. W. Galbraith, (Brookhaven National Lab., Upton, N. Y.), E. W. Jenkins, T. F. Kycia, B. A. Leontic, R. H. Phillips, A. L. Read, and R. Rubinstein. Phys. Rev., 138: B913-20(May 24, 1965). (BNL-8744)

The total cross sections σ_T of p, $\bar{p}$, $\pi^\pm$, and $K^\pm$ on hydrogen and deuterium were measured between 6 and 22 Bev/c at intervals of 2 Bev/c to an accuracy greater than previously reported. The method utilized was a conventional good-geometry transmission experiment with scintillation counters subtending various solid angles at targets of liquid H_2 and D_2. With the increase in statistical accuracy of the data, it was found that a previously adopted procedure of linearly extrapolating to zero solid angle the partial cross sections measured at finite solid angles was not a sufficiently accurate procedure from which to deduce σ_T. The particle-neutron cross sections are derived by applying the Glauber screening correction to the difference between the particle-deuteron and particle-proton cross sections. The cross sections $\sigma_T(\pi^+d)$ and $\sigma_T(\pi^-d)$ are equal at all measured momenta, which confirms the validity of charge symmetry up to 20 Bev/c. Results are presented showing the variation of cross sections with momentum; evidence is presented for a small but significant decrease in $\sigma_T(pp)$ [and $\sigma_T(pn)$] in the momentum region above 12 Bev/c. (auth)

25352 PION-NUCLEON PHASE-SHIFT ANALYSIS: 0-350 Mev. L. David Roper and Robert M. Wright (Univ. of California, Livermore). Phys. Rev., 138: B921-32 (May 24, 1965). (UCRL-12198)

Several sets of energy-dependent pion-nucleon phase shifts were obtained in the 0–350-Mev energy range. These solutions differ near the end of the energy range and in the signs and magnitudes of some of the small phases. There is very little difference among these solutions in their prediction of the observables, including the spin-rotation parameters. Some very difficult experiments are suggested to distinguish among the solutions. (auth)

25353 MINIMAL BOOTSTRAP IN MESON–BARYON SYSTEMS. Rudolph C. Hwa and Sharashchandra H. Patil (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 138: B933-7(May 24, 1965).

Two-particle scattering systems for which the crossing matrices give a good estimate of the nature of forces are considered. A bootstrap state is defined to be an eigenvector of the total crossing matrix. It is shown that bootstrap schemes are generally not unique. It is conjectured that the physical particles manifest themselves in a state of minimal bootstrap, that is, a scheme involving the participation of the least number of particles. By studying meson-baryon scattering in the SU(2) and SU(3) symmetries, substantial evidence is found in support of this conjecture. The re-

sults are not only that the minimal bootstrap vectors accommodate the observed particles in the usual way, but also that the ratio of the coupling strengths of particles in different representations and the mixing parameter (D/F ratio) of the Yukawa-type octet coupling both turn out to agree with experiments. (auth)

25354 OPTICAL ANALYSIS OF THE 900-Mev π^--p RESONANCE. W. R. Johnson, F. C. Smith, and P. C. DeCelles (Univ. of Notre Dame, Ind.). Phys. Rev., 138: B938-42(May 24, 1965).

A model for elastic scattering near the 900-Mev π^--p resonance is proposed, consisting of a Breit-Wigner term together with an optical background. The optical background is chosen to fit experimental data beyond the 900-Mev resonance; the spin of the Breit-Wigner term is then adjusted to give an elastic cross section in agreement with experiment. A distorted-wave Born-approximation calculation shows a spin-$\frac{5}{2}$ resonance term to be in agreement with the data, in accord with the usual spin assignment. Parity of the Breit-Wigner term cannot be decided from the elastic energy spectra and angular distributions alone; however, if the elastic resonance is identified with the observed Λ-K resonance near 900 Mev, one finds a suitable branching ratio only for the $D_{\frac{3}{2}}$ choice. The resulting Λ-K angular distributions, as well as the production cross section as a function of energy, agree generally with experiment. It is therefore proposed that the 900-Mev π^--p resonance has negative parity relative to the proton. (auth)

25355 TIME DEPENDENCE OF μ POLARIZATION IN THE LEPTONIC DECAY OF THE K° MESON. Brian G. Kenny (Univ. of Chicago) and Robert G. Sachs. Phys. Rev., 138: B943-6(May 24, 1965). (COO-264-226)

The transverse polarization of the muon in the $(\pi\mu\nu)$ decay of the K^0 is calculated as a function of time under the assumption of complex form factors, i.e., breakdown of T invariance. It is shown that the nature of the time dependence depends on relative phases and magnitudes of the four form factors f_+ and f_- for $\Delta S = \Delta Q$ and g_+ and g_- for $\Delta S = -\Delta Q$. If $g_+ = g_- = 0$, the relative transverse polarization is constant in time and its value depends on the relative phase of f_+ and f_-. In order for the polarization to vary with time, it is necessary that either g_+ or g_- be different from zero; hence a measurement of the time dependence provides a direct test of the $\Delta S = \Delta Q$ rule. Even if the form factors are real (i.e., T invariance is valid), the transverse polarization will be nonvanishing for a time comparable to several K_1^0 lifetimes as long as $f_+g_- - f_-g_+$ is different from zero. (auth)

25356 LOW-ENERGY K-N SCATTERING AND SU(3) INVARIANCE. Robert L. Warnock (Illinois Inst. of Tech., Chicago and Argonne National Lab., Ill.) and Graham Frye. Phys. Rev., 138: B947-68(May 24, 1965).

Phase shifts from K_+-p and K_+-d scattering up to 800 Mev/c are fitted by a sum of single-particle exchange terms and a background term representing unknown short-range forces. The background is described by a low-order polynomial in s and t in the invariant amplitudes. The single-particle states in the u-channel are Λ, Σ, Y_1^*(1385 Mev), Y_0^*(1405 Mev), Y_1^*(1520 Mev), and Y_1^*(1660 Mev). A continuum of u-channel $\overline{K}$-N scattering below 400 Mev/c is also included. In the t channel the states are ρ and a fictitious particle x which is supposed to represent the average effect of ω and φ. The $Y^*N\overline{K}$ coupling constants are known from experiment or a combination of theory and experiment. The ratio of vector to tensor ρNN coupling constants is taken from nucleon electromagnetic-structure data. The other coupling constants are regarded as free parameters to be determined by fitting K-N data. For good fits it is necessary to retain the first three orders in the expansion of the background term. This entails eight free parameters. Two sets of fits to the data are found, one with the Fermi-type I = 0 phase shifts ($\delta_{P_{\frac{3}{2}}}$ large and positive) and one with Yang-type I = 0 phases ($\delta_{P_{\frac{1}{2}}}$ large and positive). In the Fermi case the Σ and ρ coupling constants each differ by more than five standard deviations from predictions based on SU(3) symmetry. The Σ constant also disagrees badly with results from forward-angle dispersion relations. In the case of the Yang-type phase shifts, the coupling constants are essentially in agreement with SU(3) predictions. In the Yang case the ρ term is necessary for an acceptable fit, in spite of the large number of parameters. The parameters for x exchange are badly determined by the data, so there is no possibility of working with ω and φ coupling constants as separate free parameters. Exchange of scalar particles is considered as a model for the effects of "ABC" or "σ" π-π interactions at 310 or 400 Mev, and the K_1-K_1 interaction at 1000 Mev. Inclusion of such exchange terms affects the parameter values of the other terms only slightly, and therefore does not change the qualitative character of the fits to the data. The Y* terms can also be omitted without changing the general character of the fits. They are not small, but they are well represented by the background terms. Unitarity corrections are estimated to be rather minor; they do not change the main conclusions. (auth)

25357 MUON POLARIZATION AND ENERGY SPECTRUM IN $K^+ \to \pi^0 + \mu^+ + \nu$. D. Cutts, T. Elioff, and R. Stiening (Univ. of California, Berkeley). Phys. Rev., 138: B969-79(May 24, 1965). (UCRL-11892)

The number of muons in the high-energy region of the continuum in the reaction $K^+ \to \pi^0 + \mu^+ + \nu$ was measured. The portion of the spectrum explored extended from 107.1 to 126.4 Mev. The longitudinal polarization of the muons was measured in the same energy interval by observing the spatial anisotropy of the e^+ from muon decay. The rate of decay with a muon in this energy interval was found to be 0.054 ± 0.008 of the total K^+ decay rate in the mode $K^+ \to \pi^0 + e^+ + \nu$. The polarization of the muons was found to be $+0.61 \pm 0.39$. These results are consistent with an analysis made assuming constant form factors, pure vector coupling, and equal muon and electron weak-coupling strength. A real or imaginary vector form-factor ratio $\xi = f_-/f_+$, is consistent with the data. If ξ is real, the most probable solution is $+0.2 < \xi < +1.4$. As a calibration experiment, the polarization of muons from $K^+ \to \mu^+ + \nu$ was also measured. It was found to be -0.94 ± 0.21. (auth)

25358 HIGH-ENERGY NEUTRINO EXPERIMENTS. D. H. Perkins (Univ. of Bristol, Eng.). Proc. Roy. Soc. (London), Ser. A, 185: 191-201(Apr. 20, 1965).

The information to be obtained from high-energy neutrino experiments is outlined, together with the technical details of a neutrino experiment. Experimental results relating to the two-neutrino hypothesis, the intermediate boson, elastic and inelastic processes, and neutral weak currents are reviewed. (D.C.W.)

25359 LEPTONIC DECAYS OF STRANGE PARTICLES. H. H. Bingham (CERN, Geneva). Proc. Roy. Soc. (London), Ser. A, 285: 202-13(Apr. 20, 1965).

Experimental results on strange particle leptonic decays are summarized and compared with predictions based on the $\Delta S = +\Delta Q$, $|\Delta I| = \frac{1}{2}$ and $\Delta S \pm 2$ rules, CP invariance and electron-muon universality. Recent (and still preliminary) results on $K_{\mu 2}^0 \to \pi^+ + e^- + \nu$, $K^+ \to \pi^+ + \pi^+ + e^- + \nu$ and $\Sigma^+ \to N + (\mu \text{ or } e)^+ + \nu$ are compatible with little (< 10%) or no violation of the $\Delta S = +\Delta Q$ rule. Three-body leptonic decay rates of K^+ and K^0 disagree by about two standard deviations with the $|\Delta I| = \frac{1}{2}$ rule prediction, but the agreement is restored if about 10% $|\Delta I| = \frac{3}{2}$ admixture is allowed. No $\Delta S = 2$, $\Xi^- \to N + e^- + \nu$ or $\Xi^0 \to p + e^- + \nu$ decays have been observed to the level of about 1% of the normal decays. All the data are in good agreement with time reversal or CP invariance and with the assumptions that the lepton pair is coupled locally and that electrons and muons behave identically apart from effects of their mass difference. The branching ratios for the various hyperon leptonic decays and the observed V– A form for Λ_β decay are explained qualitatively by the theory of Cabibbo, for example; but the data are not yet precise enough for a sharp test of the theory. New data on $K^+ \to \pi^0 + (e \text{ or } \mu)^+ + \nu$ spectra, branching ratios and muon polarization indicate that the interaction is of the vector form with approximately con-

stant form factors and that the form factor ratio f_-/f_+ is of order 1 or compatible with 0, as in the case of $K_2^0 \rightarrow \pi^+ + e^- + \nu$. (auth)

25360 WEAK INTERACTIONS. P. T. Matthews (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 285: 214-28(Apr. 20, 1965).

A review of the present status of weak interactions is presented, with particular reference to the implications of a current-current interaction, the $\Delta Y/\Delta Q$ rule for currents, and the $\Delta I = 1/2$ rule for non-leptonic transitions. 80 references. (auth)

25361 THE WEAK INTERACTIONS OF THE MUON. R. H. Dalitz (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 285: 229-47(Apr. 20, 1965).

A survey on meson (μ) decay, meson (μ^-) capture by hydrogen and complex nuclei, and leptonic decays of strange particles is presented. The accuracy and detail with which the weak interactions of the electron and the meson (μ) are identical in form are emphasized. Only the hypothesis that these leptons participate in weak interactions only through the charged current vectors and its Hermitian conjugate is considered. (D.C.W.)

25362 HIGH-ENERGY MUON INTERACTIONS. F. J. M. Farley (CERN, Geneva). Proc. Roy. Soc. (London), Ser. A, 285: 248-56(Apr. 20, 1965).

The magnitude of the coupling constants for meson (μ) coupling to the intermediate boson and to a heavy photon (neutral vector boson χ) are considered, and the effects to be expected from the heavy photon are discussed. Coupling of the χ particle to the meson (μ) alone; to the meson (μ) and the mu neutrino; and to the meson (μ), the mu neutrino, and a nucleon are considered. (D.C.W.)

25363 CANONICAL REPRESENTATIONS FOR MASSLESS PARTICLES AND ZERO-MASS LIMITS OF THE HELICITY REPRESENTATION. A. McKerrell (Univ. of Glasgow). Proc. Roy. Soc. (London), Ser. A, 285: 287-96 (Apr. 20, 1965).

The global forms of the unitary irreducible representations of the inhomogeneous Lorentz group corresponding to zero mass and finite or continuous spin are constructed by means of the little-group technique from those of the two-dimensional Euclidean group, and it is shown that these representations may be derived from the helicity representation for positive mass by taking suitable limits. (auth)

25364 THE COVARIANT THEORY OF STRONG-INTERACTION SYMMETRIES. [PART] II. A. Salam, R. Delbourgo, M. A. Rashid, and J. Strathdee (International Centre for Theoretical Physics, Trieste, Italy). Proc. Roy. Soc. (London), Ser. A, 285: 312-18(Apr. 20, 1965).

The relativistic structure of the 143, 364, 572, 4212, and 5940 $\tilde{U}(12)$ multiplets is exhibited in the conventional wave formulation of quantum fields. Expressions for free Lagrangians, free propagators, and interaction Lagrangians are given for S-matrix calculations. These last multiplets (4212, 5940) include spin-2 particles for which experimental evidence has recently been accumulating. (auth)

25365 THE THEORY OF WEAK INTERACTIONS. J. C. Taylor (Cambridge Univ., Eng.). Rept. Progr. Phys., 27: 407-67(1964).

A review on the theory of weak interactions is presented, covering invariance principles, lepton decays and interactions, nonleptonic decays, and electromagnetic corrections. (D.C.W.)

25366 ON THE WEAK INTERACTION. S. Nakamura. Soryushiron Kenkyu, 28: 1-19(1963). (In Japanese)

The problem of unifying the weak and strong interactions is considered, and the distinction between the allowed and first forbidden transitions for the strong and weak interactions of baryons with pions and kaons and the weak interactions of fermions with the intermediate boson is discussed on the basis of selection rules. (L.B.S.)

25367 ON THE PHILOSOPHY OF THE S-MATRIX SCHOOL: ON COMPOSITE MODEL, WEAK INTERACTION AND LANGER EFFECT. S. Sakata. Soryushiron Kenkyu, 28: 110-14(1963). (In Japanese)

It is considered that the recent field theory is not absolute and final and will perhaps be replaced by Chew's anti-field theory and that the philosophy of the S-matrix school for "annihilation of matter" is unsatisfactory. The argument of Regge pole is interesting in the sense that physics is not limited to the discussion of the analyticity and symmetry. The model is suggested on the basis of the infinite step-characteristics of the matter and the differences among p, n, and Λ phases from which all the elementary particles are deduced. The common properties of p_1, n and Λ are, however, emphasized by Ogawa and Klein. It is pointed out that the model presented is not one of G-N type but is analogous to the Markov model with the characteristics of a logic at the back of the symmetry. Although it is at present based on the field theory it will be necessary to express it in the anti-field theory when the three types of Urmaterie corresponding to p, n, and Λ will be considered and the Regge poles taken as the elementary particles. Even though it is still of Lorentz invariance, the interpretation is by no means absolute. The Langer effect is currently explained by the non-localization of interaction and the processes of the emission of other particles. The following possibilities exist for the latter: the emission of more than two neutrinos; the emission of neutrinos with mass; the emission of boson neutrino; the emission of neutrino with spin $3/2$; and the effect of internal bremsstrahlung. Taketani-Tati's induced decay ($\Delta S/\Delta R = -1$) can be described by the introduction of the neutral intermediate boson V on the basis of the Nagoya model. For instance, in the $K_0 \rightarrow \pi + e^- + \nu_e$, the Langer effect can be understood if ν_μ is with a mass. It may also be described by the Bose neutrino which is taken to be a bound state of μ^- and e^+. (auth)

25368 THE METHODS OF CONSIDERATION FOR THE STRUCTURE OF ELEMENTARY PARTICLES. S. Taketani. Soryushiron Kenkyu, 28: 115-20(1963). (In Japanese)

Several methods for the structure of elementary particles are reviewed. The symmetries of the p,n, and Λ are considered in the framework of the Sakata model, the single nuclear particle model and group theory. The factors which determine the masses of elementary particles are discussed. The relations between cross sections and masses, according to the classical and quantum considerations, are also considered. (L.B.S.)

25369 ON THE THEORY OF WEAK INTERACTION. J. Maki. Soryushiron Kenkyu, 28: 121-5(1963). (In Japanese).

The fundamental facts, the various total schemes, and some problems of weak interactions are reviewed. (L.B.S.)

25370 THE MASS RELATIONS BETWEEN PARTICLES AND RESONANCES. Y. Katayama and K. Mastumata. Soryushiron Kenkyu, 28: 126-36(1963). (In Japanese)

Experimental data of the masses of elementary particles and resonances, Nambu number, the relations between the mass and the quantum numbers and the mass formulas and resonance levels deduced from symmetry are presented. The relation between the mass formula and the rotator model is also discussed. (L.B.S.)

25371 THE EXTENDED PARTICLE MODEL. ISOTOPIC SPIN AND ELECTROMAGNETIC FIELD. Hara Osamu. Soryushiron Kenkyu, 28: 137-55(1963). (In Japanese)

The rotator model suggested by Takabayashi is investigated. The relation of I_3 to the electromagnetic field is correctly introduced by reproducing the charge independence by means of Kaluza's five dimensional space whose fifth coordinate defines the radius of the elementary particles. The extended model is similar to the Sakata model, and the electromagnetic field, weak interaction and the B-field are logical results of the extension of particles. The investigation gives a unified explanation for the mass spectrum, the structure of interaction, the divergence difficulty and the fundamental problems in the theory of elementary particles. (L.B.S.)

25372 THE MODEL SOLVABLE BY DISPERSION RELATION OF PARTIAL WAVE AND THE BOOTSTRAP APPROXIMATION. A. Kanazawa and N. Takuda. Soryushiron Kenkyu, 28: 163-70(1963). (In Japanese)

It is asserted that a model solvable by dispersion relation of partial wave should be considered in the study of the effect of bootstrap approximation. For particles in the strong interaction the bootstrap mechanism is regarded as applicable to many practical problems. In this model, the high energy limit is a non-zero finite value ξ when the scattering amplitude of p-wave satisfies the simple crossing relation. The elastic unitarity is modified on account of the smooth cut-off introduced into the high energy. The model corresponds to the relativistic pion–pair theory which describes the interaction of p-wave. The dispersion relation of amplitude is correctly resolved by the inverse method. A resonance with a positive width may appear in some regions with ξ. The bootstrap equation for the resonance may be formulated by the N/D method and its numerical resolution obtained. The results are as follows. The solution of bootstrap equation after multiple iteration for the position of the resonance is an approximate value of the correct solution. The approximate value of the correct solution of a reduced width is obtained only for large Λ but not for small Λ. For the bootstrap equation the approximated solution is generally smaller than the correct one. The convergence of iteration is good. The effect of iteration, except in cases near the resonance threshold, is not unduly prominent. Results may not always be refined by the effect of iteration. How far are these results applicable to the practical problems is not clear in the bootstrap approximation since a logarithmic branch-cut without pole appears. The inelastic processes may not be neglected; but the qualitative characteristics of the solution are not sensitive to it since the left-hand discontinuity is contained in the dispersion relation in an integral form. Moreover, these processes may be considered phenomenologically by the cut-off introduced in the previous model. (auth)

25373 ON THE THRESHOLD EFFECT. Y. Fuji. Soryushiron Kenkyu, 28: 178-83(1963). (In Japanese)

Some threshold effects which exist in the observed resonances are investigated. A quantitative relation $r/2 \geq \Delta$ is found, where Δ is the sum of half widths of the unstable particles containing inelastic channels, and $r/2$ is the half-width of the peak produced as a threshold effect. Its lower limit is $\sqrt{2\Delta}$ provided the center of the peak is consistent with the threshold (defined as the central value of mass of the unstable particles). The method is obtained by first considering the system of two stable particles whose inelastic channel is taken as a S-wave. The analyticity of scattering amplitude should be studied on the complex k plane (the momentum of inelastic channel in a center-of-mass system) if only the physical cut is taken into account. The central value of mass of the unstable particles is used. A few examples of application are tabulated. (auth)

25374 BOSON LEVEL AND THE COMPOSITE MODEL. S. Furui, S. Furuishi, S. Ishida, S. Kawagaki, and H. Sawamura. Soryushiron Kenkyu, 28: 184-9(1963). (In Japanese)

The mass spectrum of the particles is dynamically described on the basis of the symmetrical Sakata model. The levels of bosons which can be regarded as the bound states of baryons and anti-baryons are found with the mass difference Λm of N and Λ taken into account. The reaction amplitude of baryon and anti-baryon is expanded to partial wave using the N/D method. The calculation method is suitably modified to assure the time reversal invariance since a multichannel problem may be caused by $\Delta m = 0$. The zero points of D obtained correspond to the bound states. The left-hand cut is neglected and the long range force is also disregarded for the bound states. The interaction Hamiltonian is constructed, and the coupling constants are selected assuming that the masses of $\pi-$, $\omega-$ and ABC-mesons are equal to their experimental values, respectively. It is further assumed that m_p = the experimental value of m_r $C'_A \approx 0$ and the place of pole is in the positive region of S (= energy square). The masses of bosons found under these conditions are listed. (auth)

25375 MEASURING TOTAL CROSS SECTIONS FOR π^+-MESON INTERACTIONS WITH PROTONS AT 2.5 TO 5 Bev/c. Nai-sen Chang. Wu Li Hsueh Pao, 20: 1244-53 (Dec. 1964). (In Chinese)

By the use of electronics the total cross sections for the interaction of π^+ mesons with protons at 2.72, 3.70, and 4.75 Bev/c were measured by the method of emitted particles from a synchrophasotron beam in good geometry. The π^+ mesons were separated from the beam of positive particles by a threshold Cherenkov detector. For verification, the total cross section for p-p interactions at 2.72 Bev/c was measured. The measurement results showed that in the momentum interval from 2.5 to 5 Bev/c the total cross section for the interaction of π^+ mesons with protons, in the limits of experimental error, becomes constant and equal to ~29 mb. From the general trends of the total cross section of π^+p and π^-p interactions, it is seen that, in the limits of experimental error, the total cross sections in the interval given converge. The verification of the theorem of Pomeranchuk on the equality of the π^+p and π^-p total cross sections at high energies was considered. (tr-auth)

25376 ON THE CALCULATION OF MASS VALUES OF SCALAR MESONS IN THE NONLINEAR SPINOR THEORY. H. Stumpf and H. Yamamoto (Max-Planck-Institut fur Physik and Astrophysik, Munich). Z. Naturforsch., 20a: 1-12 (Jan. 1965). (In German)

In the nonlinear spinor theory with Heisenberg noncanonical quantization, the second approximation for the calculation of meson masses leads to an integral equation for the mass element $\langle 0|T\psi_a(x)\,4\chi^*(y)|a\rangle$. The equation was reduced in the cms by a spin-isospin algebra, and the Fredholm theory of spinor integral equations was applied as the solution method. For simplification of the solution method, the propagator occurring in the integral equation was regularized with ghosts of finite rest mass, and group-theoretical analysis of the wave functions was undertaken for the classification of the solutions. The eigenvalue problem can be solved approximately for the spin-zero particle and given the masses for the π and η mesons in dependence on the ghost mass. (tr-auth)

25377 PHOTOPRODUCTION OF K^+ MESONS IN HYDROGEN AT 1160 Mev. Ahren Joel Sadoff. Thesis, Ithaca, N. Y., Cornell Univ., 1964. 106p.

Measurements were made of the angular distribution of K^+ mesons in the reaction $\gamma + p \rightarrow K + \Lambda$ at a photon energy of 1160 Mev with center-of-mass angles from 36° to 135°. The results are similar in general character to those obtained by Anderson et al. at 1054 and 1080 Mev and by Peck at 1200 Mev. The angular distribution varies only slowly in this 150 Mev interval. The K^+ mesons are selected by magnetic momentum analysis, time of flight, and specific ionization. Threshold Čerenkov counters discriminate against protons and π^+ mesons. A background of fast protons scattered from the magnet walls is rejected by placing thin scintillation counters inside the magnet to define the particle trajectories. This additional discrimination reduces the measured background to 10% or less of the K^+ meson yield. This eliminates the necessity of stopping the K^+ mesons in order to identify them by their decay products. The low-energy theories of Kuo, Beauchamp, and Holliday, and Hatsukade and Schnitzer are discussed. Their prediction of the behavior of the cross section at 90° in the center of mass as a function of energy is compared with the experimental results. A discussion of the relevance of these theories to production energies greater than 1100 Mev is also included. Considerations and suggestions for future experiments are presented in conjunction with an analysis of the limitations of the present experimental arrangement. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25378 THE BRANCHING RATIOS OF THE POSITIVE K MESON. Francis Sowersby Shaklee. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 70p.

In order to experimentally measure the decay branching ratios of the K^+ meson a separated beam of K^+ mesons of momentum 700 Mev/c was brought to rest in a 12-in. dia, 10-in. deep xenon bubble chamber at the Bevatron. The decays are classified according to the nature of their charged secondaries and the number of electron pairs from gamma rays from their π^0 secondaries. Certain decay modes are simulated by a Monte Carlo technique in order to determine various probabilities that are vital to the calculation of the branching ratios. Corrections are made for the multiple scattering of charged secondaries, for measurement errors, and for contamination of the final sample by decays in flight which are undetectable in scanning. The branching ratios of the $K_{\mu 2}$, $K_{\mu 3}$, K_{e3}, $K_{\tau 2}$, τ, and τ' decay modes were calculated giving, in percent, 63.0 ± 0.8, 3.0 ± 0.5, 4.7 ± 0.3, 22.4 ± 0.8, 5.1 ± 0.2, and 1.8 ± 0.2, respectively. These results are compared with previous experimental determinations of the K^+ branching ratios, three of which were done with emulsions and one with the same xenon bubble chamber used in the present experiment. This experiment supports the latter fairly well except for the $K_{\tau 2}$ and $K_{\mu 3}$ branching ratios, in which cases the present experiment is more in agreement with the emulsion results. The results are also compared with some theoretical predictions. The three-pion decays of the K^+ meson afford an opportunity to check the $\Delta T = \frac{1}{2}$ rule. If the rule is valid, the ratio of the τ' to τ decay rates, including corrections for phase space, is 0.325. The present experiment yields 0.350 ± 0.039, which is in agreement with the $\Delta T = \frac{1}{2}$ rule. The value of the $K_{\mu 3}/K_{e3}$ decay ratio obtained was 0.63 ± 0.10, which is lower than that of previous experiments and is consistent with $f_- = 0$. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25379 DIRECT PAIR PRODUCTION BY HIGH ENERGY MUONS. Philip Daniel Kearney. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 107p.

A multiplate Wilson cloud chamber was operated 8.42×10^4 g/cm^2 underground to measure the rate of production of knock-on and direct pair electrons by high energy muons. A scintillator telescope was used to trigger the chamber. The energies of the events were determined from the total number of track segments in the showers and the results of a recent shower experiment by Hazen and Hendel. The numbers of showers vs. shower energy were plotted on histograms for comparison with direct pair and knock-on theory. The muon spectrum for the mine location was calculated using the measured and extrapolated surface spectrum for the vertical and various zenith angles. An energy loss equation was then used with the surface spectrum to obtain the mine spectrum. The resulting spectrum was folded into the evaluated cross sections to obtain the expected number of events. The histogram of the total number of showers vs. shower energy shows good agreement between theory and experiment, as does a similar histogram including only the results of the muons inclined at steep angles. An attempt was made to separate direct pair from knock-on results. The results of this separation showed good agreement with direct pair theory. However, there was a significant disagreement with knock-on theory. Examination of possible bias and systematic error indicated that for shower energies above 1 Bev, this discrepancy could not be accounted for by the experimental uncertainties. Comparison with experimental results of others suggests an examination of existing knock-on theory. Agreement between theory and experiment was found for nuclear interactions of muons, although this conclusion is based on only three observed nuclear interactions. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25380 WEAK AND ELECTROMAGNETIC INTERACTIONS IN QUATERNION QUANTUM MECHANICS. Morton Allen Tavel. Thesis, New York, Yeshiva Univ., 1964. 105p.

A description of spin-$\frac{1}{2}$ particles within the framework of quaternion quantum mechanics is sought. These particles will serve as test bodies to investigate the interaction properties of two fundamental quaternionic fields tentatively identified with the photon and intermediate boson. The test particles are described by a Lagrangian because of the ease of incorporating conservation laws within such a framework. The description is to be regarded as phenomenological. To this end a quaternionic generalization of the complex Dirac Lagrangian, $L = \psi^{H\dagger}i\gamma^0(\gamma^\mu\partial_\mu + m)\psi$, is required. The resulting equation is considered as describing baryon fields and its invariances in the absence of interactions are examined. The interaction between the test baryons, leptons and the fundamental bosons is considered. The interaction propagated by the neutral massless boson exhibits all the properties of the electromagnetic interaction, conserving charge (Q), hypercharge (y), third component of isospin I_3, and baryon number (B) but breaking the I symmetry of the free Lagrangian. The interaction with the charged massive boson differs from the accepted form of the weak interactions in that it conserves parity. It does, however, correspond to the weak interactions in that it conserves Q and B while violating I and baryonic Q and I_3. Y is conserved, which corresponds to the fact that our interaction considers only $\Delta S = 0$ transitions. It should be noted that the violations of $\bar{I}$ symmetry in the electromagnetic interaction and the violations of $\bar{I}$ and baryonic I_3 in the weak interactions come about in a natural, unavoidable way. The fact that parity is not violated can be remedied by the standard procedure of inserting a parity-violating term in the interaction Lagrangian. (A.G.W.)

25381 A CLASSICAL LIMIT OF PSEUDOVECTOR MESON SCATTERING. Richard L. Knight. Thesis, Logan, Utah, Utah State Univ., 1964. 82p.

Equations of motion for nucleons interacting with mesic fields have been derived by Havas from the points of view of both field theory and action-at-a-distance. Chatelain noticed that the action-at-a-distance theory closely resembles Heitler's quantum theory of radiation damping and compared the results of the two theories for a wide range of scattering and photoproduction processes. The comparison study initiated by Chatelain is extended to include processes involving pseudovector mesons. The cross sections calculated with the aid of the Heitler theory were found to reduce in the classical limit to those derived from Havas' action-at-a-distance theory. Heitler's radiation damping equation is $U_{ab} = H_{ab} + \Sigma_c i\pi\rho d\Omega H_{ac} U_{cb}$. The H_{ab} are second order Born approximation matrix elements. In order to obtain these, the pseudovector field was quantized and in anticipation of a future solution to order $1/M$ in the nucleon mass, a Foldy-Wouthuysen transformation was carried out on the neutral pseudovector field. The nonrelativistic and finally the classical limits were taken. The summation indicated above is over all intermediate states that are possible final states. Because this sum involves a continuum as well as discrete states, the expression is an integral equation for U_{ab}. By writing similar equations for incident and scattered mesons with various polarizations a system of simultaneous integral equations is obtained. This system may be conveniently solved by putting $U_{fi} = X_{fi}k_fk_i + Y_{fi}k_ik_f$, and determining the coefficients X_{fi} and Y_{fi}. Finally, differential scattering cross sections are obtained from the solutions, U_{fi}, of the damping equation. The cross sections for charged mesons with PV(PV) coupling and for neutral mesons with PV(PV) coupling are given. These are all in agreement with Craft's classical action-at-a-distance cross sections. Cross sections for charged and neutral mesons with PV(T) coupling are also calculated. (A.G.W.)

25382 AN INVESTIGATION INTO OPERATOR STRUCTURES ON SU_n WITH APPLICATION TO A GENERALIZATION OF THE RACAH-WIGNER ANGULAR MOMENTUM ALGEBRA. Gordon Edward Baird. Thesis, Durham, N. C., Duke Univ., 1964. 91p.

The explicit determination of the generators of the unitary groups SU_n is carried out and discussed in two alternative treatments: (a) by purely algebraic infinitesimal methods, and (b) by Young-pattern techniques employing the Schwinger-Bargmann boson operator methods. The matrices of the generators are used to determine the conjugation operation for SU_n; the SU_n equivalent of the Wigner "1 – j symbol" is determined by the conjugation

operation. In addition to this Wigner coefficient the [λ] × [1] Wigner coefficient is given for all SU_n. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25383 A GENERAL APPROACH TO THE BOUND STATES OF SEVERAL NUCLEONS. Richard Kent Cooper. Thesis, Tucson, Ariz., Univ. of Arizona, 1964. 53p.

The equations of motion of a system of N nucleons are written, using the most general velocity-independent, parity-conserving, two-body potential between pairs of nucleons. The spin and isospin dependences are eliminated by established techniques involving use of the theory of the group of permutations of N objects. The center-of-mass coordinates and orientational dependences are eliminated by re-expressing the operator for the kinetic energy in terms of suitable variables and using techniques of angular momentum theory. The equations for all possible three-nucleon problems are written in detail, i.e., the parameters appearing in the N-nucleon equations are given explicitly and the coupled differential equations for the amplitudes of the various states of spin, isospin, and angular momentum are displayed. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25384 NEUTRINO SCATTERING AT HIGHEST ENERGY. David Greenhill Ellis. Thesis, Ithaca, N. Y., Cornell Univ., 1964. 73p.

If the force between two leptons is mediated by the exchange of a charged vector meson of mass m, and if the meson field is coupled directly to the lepton current in the most natural way to preserve the "V-A" character of the low energy interaction, then the cross section for elastic scattering of two leptons reaches a constant value at high energy, and this value is proportional to m^2. On the other hand, the limit imposed by unitarity is proportional to m^{-2} for any reaction where a mass m is exchanged. Thus there is a maximum permissible m for which this theory may be used. It is found that m must be less than about 170 Bev; if this extreme is reached, the cross section at very high energy becomes about 10^{-33} cm^2. However, the meson theory that gives these results is not renormalizable, and gives impossible answers for certain processes involving real mesons. A simple way to keep the successes of the meson theory and get rid of the divergence is to introduce some structure into the lepton current. Each vertex involving a virtual lepton is multiplied by a single scalar form factor, which is an analytic function of the squared mass of the virtual lepton. The most natural choice of functional form leads to a pair production cross section which is still independent of m, and which rises to a maximum and then decreases for very high energies. The maximum value is proportional to M^2, and occurs for the center of mass energy equal to M. Here M is the parameter that sets the scale of the form factor. The unitarity requirement now gives an upper limit for M of about 800 Bev. This corresponds to a limit on the cross section of about 10^{-34} cm^2. The lepton scattering reaction is independent of M, while the pair production process, for high enough energy, is independent of m. If either reaches its limit, the corresponding effective coupling constant, GM^2 or Gm^2 for exchange of lepton or meson respectively, will be of the order of unity, so that the interaction will be a strong one in the sense that higher order processes become very important at high energy, and any total cross section would be expected to achieve a constant geometrical value, as happens in the case of the strong interaction. The magnitude of the cross section however, according to the present model, will be much smaller, due to the short range of the force—at best about 10^{-33} cm^2 total cross section per target particle. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25385 INVESTIGATION OF DI-PION RESONANCES IN 3.7 Bev/c π^-p COLLISIONS. Yong-Yung Lee. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 88p.

Using the Brookhaven National Laboratory 20-inch hydrogen bubble chamber, the three-body final states produced in π^-p collisions were studied. The beam used was the 3.7-Bev/c separated π^- beam at the Alternating Gradient Synchrotron. Identified events included 1,054 events of the reaction $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ and 1,693 events of the reaction $\pi^- + p \rightarrow \pi^- + \pi^+ + n$. The pion-pion mass spectra for these reactions are strongly peaked at 795 Mev, indicating abundant production of ρ^- and ρ^0 mesons. An analysis of the decay angular distributions of the events in these peaks leads to an interpretation of these events as being produced via pion-pion scattering in states of angular momentum zero and one. A detailed analysis of the energy and momentum transfer dependence of the phase shifts necessary to describe such scattering is made. Using the Chew-Low method the results were extrapolated into the non-physical region of momentum transfer and good quantitative agreement with predicted values was found. The $\pi^+ \pi^-$ spectrum had another resonance peak at 1250 Mev due to the f^0 meson. The spin of the f^0 is determined to be greater than one. Production cross sections for the various channels are also presented. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25386 EXTRAPOLATION OF NUCLEON ELECTROMAGNETIC FORM FACTORS. J. S. Levinger and C. P. Wang (Cornell Univ., Ithaca, N. Y.). 46p. (CONF-758-5)

From American Physical Society Meeting, New York, Jan. 1965.

Conformal transformations are used to facilitate extrapolation of experimental values of the two isovector and two isoscalar nucleon form factors to find their spectral functions. Both isovector spectral functions peak around 600 Mev, or somewhat below the energy of the isovector resonance. Both isoscalar spectral functions peak around 700 Mev. The electric form factor for elastic electron-deuteron scattering was also analyzed in terms of the difference between the measured value and the calculated value. The latter uses assumptions concerning the deuteron wave function and concerning the isoscalar electric nucleon form factor G_{ES}. By extrapolating this difference, G_{ES} is found in the time-like region $t_A < t < 9\mu_A$, where t_A is the anomalous threshold. These values are statistically consistent with the measurements for space-like momentum transfer. Extrapolation of the combined set of values for G_{ES} (space-like and time-like momentum transfers) gives a spectral function again peaking at 700 Mev, with indication of a dip at 1150 Mev. The dip may be due to the isoscalar ϕ resonance. (auth)

25387 CONSEQUENCES OF A STRONG QUADRATIC INTERACTION OF THE WEAK INTERMEDIATE BOSON. S. Okubo. 5p. (CONF-758-13)

From American Physical Society Meeting, New York, Jan. 1965.

The consequences of assumptions on the lower limit of the mass of the W boson and that the W constitutes a U(3) triplet which has a non-zero triality are discussed. The strong quadratic interaction is considered for the scalar interaction of the W boson with baryons, the tensor interaction, the gauge-invariant interaction, and the production of W in neutrino-nucleus collisions. The production cross section for various values of the W mass and neutrino energy was calculated and compared with the results of the CERN neutrino experiment. (L.B.S.)

25388 $\pi^+ \pi^-$ SCATTERING IN π^+ d INTERACTIONS AT 4.5 Bev. W. J. Fickinger. 12p. (CONF-758-16).

From American Physical Society Meeting, New York, Jan. 1965.

The results of an investigation of π^+-π^- scattering in π^+-d interactions are presented, in which a deuterium bubble chamber was exposed to a 4.476-Bev/c meson (π^+) beam. The interaction was found to be dominated by the production of mesons (f^0) and (ρ^0), and the Yang-Treiman test for one-pion exchange of the data is briefly described. (auth)

Field Theory and Quantum Mechanics

Refer also to abstract 25600.

25389 CONTRIBUTION TO THE PROBLEM OF THE ENTROPY INCREASE OF QUANTUM MECHANICAL

MANY-BODY SYSTEMS. J. I. Horvath (Jozsef Attila Univ., Szeged). Acta Phys. Acad. Sci. Hung., 18: 145-8 (1965).

The entropy increase in many-body systems is treated in terms of coarse- and fine-grained density operators characterizing coarse- and fine-grained ensembles. It is proved that the entropy increase is independent of the coarsening method, but depends on the evolution law of the system. (D.C.W.)

25390 UNIFIED FIELD THEORY AND MODERN PHYSICS. Jerzy Rayski (Jagellonian Univ., Krakow). Acta Phys. Polon., 27: 89-97(Jan. 1965).

Five-dimensional unified field theory with a closed fifth dimension provides a geometrical interpretation of the electromagnetic field and of the electric charge. Gauge transformations mean translations, and charge conjugation means inversion in the fifth dimension. The gravitational coupling constant is related to the Sommerfield constant and to the circumference of the world-tube. The unified field theory predicts the existence of giant particles with rest masses of at least 10^{15} times the nucleon rest mass. There are indications that the five (or more)-dimensional approach may become useful for a future understanding of weak and strong interactions. (auth)

25391 "SPHERICAL" COORDINATES IN SPECIAL RELATIVITY. Cecil B. Mast (Univ. of Notre Dame, Ind.). Am. J. Phys., 33: 281-4(Apr. 1965).

In the limit at which geometric optics is valid, a light signal may be represented (in special relativity) by a (straight) null line. If an event P is considered, then the past null cone drawn from P represents all events visible to any observer at P. The configuration of events perceived by any one observer may be obtained by projecting this cone onto the 3-flat orthogonal to the observer's 4-velocity in a suitable fashion. A projection technique is described, leading naturally to a system of spherical coordinates for each observer. The transformation of coordinates for two observers is obtained, and some applications are discussed. (auth)

25392 A STUDY OF SOME APPROXIMATION SCHEMES IN QUANTUM MECHANICS. Charles Schwartz (Univ. of California, Berkeley). Ann. Phys. (N. Y.), 32: 277-91(Apr. 1965).

By means of numerical examples in one-dimensional Hamiltonian problems, the behavior of the approximation scheme known as the New Tamm-Dancoff method is studied. It is concluded that for good convergence of this, and other related methods, one should arrange to start with a symmetric set of equations. (auth)

25393 THE DEVELOPMENT OF QUANTUM THEORY. PART II. CONSOLIDATION AND EXTENSION. R. E. Peierls (Oxford Univ.). Contemp. Phys., 6: 192-205(Feb. 1965).

Some typical examples of the immediate application of quantum mechanics are presented, which illustrate the consolidation of quantum mechanics during the first few years after the completion of the basic equations. The problems of superfluidity and superconductivity are given as examples of the basic phenomena for which the use of quantum mechanics provided the foundation. Further developments in quantum theory are reviewed--problems in relativistic quantum mechanics, nuclear forces and other strong interactions, dispersion relations and symmetry principles. (L.B.S.)

25394 THE MINIMAL ELECTROMAGNETIC INTERACTIONS OF THE CHARGED SPIN 2 FIELD. L. M. Nath (Univ. of Edinburgh). Nucl. Phys., 68: 660-72(July 1965).

It is shown that for a spin 2 field there exists a family of lagrangians with an arbitrary parameter A from which, with the help of a variational principle, the equations of motion and all the subsidiary conditions can be derived. In the presence of minimal electromagnetic interactions these field equations, in the classical level, are consistent with the subsidiary conditions, irrespective of the value of the parameter A. The covariant commutation relations for the free field do not depend on the parameter A, but the propagators do. Finally, it is shown that a consistent quantization of the spin 2 field in interaction with an external electromagnetic field is not possible. (auth)

25395 THE ZILCH IN GENERAL RELATIVITY. K. S. Feldman (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 37: 104-9(May 1, 1965).

The conditions for the vanishing of the covariant divergence of traceless, bilinear combinations of Van der Waerden spinors are investigated for the electromagnetic field in the presence of gravitation, and the free gravitational field. (auth)

25396 TRANSITION OPERATOR FOR PLANE-WAVE SPINORS. D. M. Fradkin (Universita, Rome). Nuovo Cimento (10), 37: 114-21(May 1, 1965).

The transition operator which transforms a normalized plane-wave spinor of given propagation and polarization directions into another normalized plane-wave spinor with different assigned directions is constructed and discussed. It is demonstrated that this operator may be written in the form of three functions multiplying the Dirac matrices 1, $\alpha \cdot (\hat{p}_2 - \hat{p}_1)$ and $\sigma \cdot \hat{p}_2 \Lambda \hat{p}_1$. Relations connecting these three functions are given. The connection between the transition operator and the asymptotic form of the continuum wave function in potential theory is discussed. For central potentials, the interaction specifies the functional dependence of both the amplitude and the polarization direction of the outgoing wave relative to the polarization direction of the incident plane wave. (auth)

25397 NOTE ON THE VARIATION OF THE COUPLING CONSTANT IN QUANTUM FIELD THEORY. J. Soln (Univ. of California, Los Angeles). Nuovo Cimento (10), 37: 122-32(May 1, 1965).

The differential equations with respect to coupling constant are established for the S-matrix, the out states, the free-field out operators, and for the interpolating field operators. For interpolating Bose fields the microcausality condition is derived. The differential equation for the S-matrix is formulated in terms of seminormal products of free-field operators, where τ functions appear. The τ functions are discussed on one particular model of interaction, and the connection to the equation for Heisenberg field operators and to connected Feynman diagrams is found. (auth)

25398 REMARKS ON DIRAC SPURS AND PFAFFIANS. N. R. Ranganathan and R. Vasudevan (MATSCIENCE, Madras). Nuovo Cimento (10), 37: 172-8(May 1, 1965).

A recipe based on Pfaffian techniques for writing only the nonvanishing terms in the evaluation of spurs of certain types of products of Dirac matrices is given. (auth)

25399 MANIFESTLY COVARIANT QUANTUM ELECTRODYNAMICS WITHOUT UNPHYSICAL PHOTONS. A. Katz (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cimento (10), 37: 342-5(May 1, 1965).

A scheme for the quantization of the electromagnetic field is presented. The constraint equations are treated in complete analogy with the Schroedinger equation of ordinary wave mechanics, which may be regarded as expressing the constraint $E = H$ in a canonical theory symmetric in the coordinates of space and time, with $-E$ being the canonical conjugate of t. (C.E.S.)

25400 MACH'S PRINCIPLE, BARYON CONSERVATION, AND BARYON MASS. P. Roman (Boston Univ.). Nuovo Cimento (10), 37: 396-412(May 16, 1965).

Mach's principle is viewed as being incorporated into relativity by means of Dicke's scalar field theory. The assumption is made, however, that the scalar field interacts only with baryonic matter. Then it follows that the baryon current obeys an equation of continuity. Furthermore, by adopting the steady-state model of the Universe, the baryon mass becomes determined by the scalar field. Thus, both baryon conservation and the origin of the baryon mass can be regarded as a consequence of Mach's principle. In order to ensure the unrestricted validity of the equiva-

lence principle, one must allow for a pressure in the matter fields. Various cosmological consequences are discussed. (auth)

25401 ON THE UNIQUENESS OF THE POSITION OPERATOR FOR RELATIVISTIC ELEMENTARY SYSTEMS. A. Galindo (CERN, Geneva). Nuovo Cimento (10), 37: 413-22(May 16, 1965).

The regularity condition first introduced by Newton and Wigner is re-examined in some detail for the case of a relativistic elementary system [$m \neq 0, s$]. Three different types of normalizable sequences $\{\psi_n\}$ approaching some localized state ψ_a are considered, namely: A) $\psi_n(p) \in \mathcal{D}(R^3) \times \mathcal{Y}_{2s+1}$ and $\psi_n(p) \to \psi_a(p)$ in the topology of $L_2^\infty(R^3) \times \mathcal{Y}_{2s+1}$; B) $\psi_n(p) = \psi_a(p)\eta_n(p)$, where $\eta_n(p) \in \mathcal{D}(R^3)$ and $\eta_n(p) \to 1$ uniformly on any compact set; and C) ψ_n are characteristic functions in q-space with compact supports such that $\text{supp}_q \psi_n \supset \text{supp}_q \psi_{n+1} \supset \{a\}$, $\mu(\text{supp}_q \psi_n) \to 0$. It is then proved that even the ∞-order regularity condition is satisfied by all possible position operators Q if A) sequences are allowed, while the restriction to B) or C) sequences renders Q unique as soon as the 2nd order regularity condition is imposed. Finally a different but related abstract characterization is provided for the standard $Q^{(0)}$ as being that (unique) position operator for which Q^2 is essentially self-adjoint when restricted to the domain $D_{Q^2} \cap_{(\mu,\nu)} DM_{\mu\nu} \cap_{(\mu_1\nu_1,\mu_2\nu_2)} DM_{\mu_1\nu_1}M_{\mu_2\nu_2}$. (auth)

25402 QUANTIZATION OF A PARAMETRIC HAMILTONIAN FORMALISM. A. Katz (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cimento (10), 37: 745-50(May 16, 1965).

A connection is pointed out between Dirac's generalized Hamiltonian dynamics and Schwinger's method of quantum variables and group parameters. The latter is the quantized version of the former. (auth)

25403 A NOTE ON FIELD THEORIES WITHOUT MASS RENORMALIZATION. W. S. Hellman and P. Roman (Boston Univ.). Nuovo Cimento (10), 37: 779-81(May 16, 1965).

It was previously conjectured that a field theory in which no mass renormalization is necessary yields an S-matrix equal to unity. A counter example to this result is presented. A model is exhibited which satisfies the conditions that no mass renormalization is necessary, no electromagnetic interactions are included, and the boson source contains no explicit dependence on the field, but does not imply a unit S-matrix. (C.E.S.)

25404 SOLUTION OF THE SCHROEDINGER EQUATION WITH A HAMILTONIAN PERIODIC IN TIME. Jon H. Shirley (California Inst. of Tech., Pasadena). Phys. Rev., 138: B979-87(May 24, 1965).

The interaction of a quantum system with an oscillating field is studied in a formalism which replaces the semiclassical time-dependent hamiltonian with a time-independent hamiltonian represented by an infinite matrix. The formalism is developed as a mathematical equivalent to the semiclassical treatment, and interpreted as a classical approximation to the quantum treatment of the field. Combined with a perturbation theory for two nearly degenerate states, the formalism provides a convenient method for determining resonance transition probabilities including frequency shifts and multiple quantum transitions. The theory is illustrated by a detailed study of the simple case of a two-state system excited by a strong oscillating field. (auth)

25405 PHOTONS AND GRAVITONS IN PERTURBATION THEORY: DERIVATION OF MAXWELL'S AND EINSTEIN'S EQUATIONS. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 138: B988-1002(May 24, 1965).

The S matrix for photon and graviton processes is studied in perturbation theory, under the restriction that the only creation and annihilation operators for massless particles of spin j allowed in the interaction are those for the physical states with helicity $\pm j$. The most general covariant fields that can be constructed from such operators cannot represent real photon and graviton interactions, because they give amplitudes for emission or absorption of massless particles which vanish as p^j for momentum $p \to 0$. In order to obtain long-range forces it is necessary to introduce noncovariant "potentials" in the interaction, and the Lorentz invariance of the S matrix requires that these potentials be coupled to conserved tensor currents, and also that there appear in the interaction direct current-current couplings, like the Coulomb interaction. It is found that the potentials for j = 1 and j = 2 must inevitably satisfy Maxwell's and Einstein's equations in the Heisenberg representation. It is also shown that although the existence of magnetic monopoles is consistent with parity and time-reversal invariance [provided that P and T are defined to take a monopole into its anti-particle], it is nevertheless impossible to construct a Lorentz-invariant S matrix for magnetic monopoles and charges in perturbation theory. (auth)

25406 MOTION OF A CHARGE IN A GRAVITATIONAL FIELD. Moshe Carmeli (Lehigh Univ., Bethlehem, Penna.). Phys. Rev., 138: B-1003-7(May 24, 1965).

The DeWitt-Brehme equation of motion for a charged particle moving in a Riemannian space-time is examined for the case of absence of an external electromagnetic field by decomposing it into four scalar equations. This is done by introducing four orthonormal vectors along the world line of the particle and decomposing every term of the equation along them. It turns out, for example, that the "tail" has at most two nonvanishing components. The condition for a geodesic motion is discussed. It is shown that the "tail" and the local radiative damping term are not independent; the vanishing of the latter implies the vanishing of one of the two components of the "tail" and determines the other one to be a constant. The DeWitt-Brehme equation is then examined for the case of slow motion in a Schwarzchild gravitational field by expanding every term of it in a power series in 1/c (Einstein-Infeld-Hoffmann method). It is shown that the seventh-order (in 1/c) force term, which is the first radiative term, is exactly the traditional term $(^2/_3)e^2\partial^3\xi/\partial t^3$ in disagreement with a result obtained recently by DeWitt and DeWitt. (auth)

25407 THEORETICAL ASPECTS OF MIXTURES OF THERMAL AND COHERENT RADIATION. Gerard Lachs (Syracuse Univ., N. Y.). Phys. Rev., 138: B1012-? (May 24, 1965).

Some of the statistical properties of a mode of propagation for an electromagnetic field which is a superposition of thermal and coherent radiation are derived. It is found that the electric field and the magnetic field have Gaussian probability densities. The variance of the mixed field is the same as the variance of the thermal part of the field alone, while the average of the mixed field is the same as the average of the coherent field alone. It is pointed out that this result differs from the classical theory in that the zero-point field appears only once in the variance for the mixed field while it appears once in the variance of each of the constituent fields. This result is extended to a more general class of fields, and for that class it is shown that except for the zero-point field, the quantum properties of superposition are the same as the classical properties of superposition of noisy fields. The probability distribution for the number of photons in a mode of mixed radiation is also derived. The results show that there are fluctuations in the number of photons that arise, because of interference effects. (auth)

25408 OPERATIONAL FOUNDATION OF EINSTEIN'S GENERAL THEORY OF RELATIVITY. Saul A. Basri (Colorado State Univ., Fort Collins). Rev. Mod. Phys., 37: 288-315(Apr. 1965).

The measurement of time, space, and space–time intervals, and the related geometries in any gravitational field are analyzed carefully. It is pointed out that synchronization is arbitrary and very complicated operationally; and a method for doing away with it is given. Then it is shown how space geodesics can be used to construct several useful coordinate systems in an arbitrary field, and the associated coordinate conditions are derived. These co-

ordinate systems are then used to find a unique physically meaningful solution to the field equations in the cases of zero, linear, rotation, and spherically symmetric fields. (auth)

25409 PROPERTIES OF DIRAC FIELD SYMMETRY. Z. Gabos and O. Gherman. Studia Univ. Babes-Bolyai, Ser. Math.-Phys., No. 2, 83-93(1964). (In Rumanian)

A systematic analysis of the transformation properties of the Dirac field is given in an attempt to find a unitary mode of treatment for all discontinuous transformations. Bispinors, common eigenfunctions of the Hamilton operator and of the helicity operator, were used for this purpose. (tr-auth)

25410 VACUUM POLARIZATION IN THE STOCHASTIC FIELD THEORY. Billie Eugene Laney. Thesis, University Park, N. Mex., New Mexico State Univ., 1964. 72p.

Vacuum polarization corrections to scattering by an external electromagnetic field are determined within the framework of the stochastic quantum field theory. These corrections are phrased by an effective external field, which is determined in first Born approximation for small momentum transfers. The components of the effective external field as in conventional field theory, due to additional structure introduced by the fundamental length. The external field is specialized to a static Coulomb field, and stochastic corrections to the vacuum polarization part of the Lamb shift in hydrogen-like atoms are calculated. For hydrogen, these corrections amount to 0.0023 Mcps, and this result represents a finite proton effect. An investigation of the gauge invariance requirements of conventional field theory shows that the gauge invariant photon self-energy part does not, in general, correctly describe vacuum polarization effects. The gauge invariant description is, however, accurate to order k^4 in the momentum transfer k. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25411 FEYNMAN QUANTIZATION IN FIELD THEORY: TOPOLOGY OF COMMUTATORS AND FUNCTIONAL REPRESENTATION OF STATES. John Robert Hugh Dempster. Thesis, Princeton, N. J., Princeton Univ., 1964. 83p.

Feynman's sum-over-histories method of quantization has been recognized as a natural starting point for a quantum theory but has usually been considered impracticable for actual calculations. An attempt is made to work with the sum-over-histories and to show that one can make some progress through using it directly in the formulation of quantum field theory. With no attempt to give an adequate mathematical basis to functional integration, useful results are derived from a number of basic postulates about the properties of such integrals. The quantum theory of fields is formulated in these terms, and from this formulation two groups of results are derived. Each is applied to the theories of the real scalar field and the electromagnetic field, without interaction. On the one hand it is seen how the conventional formalism of non-commuting operators can be obtained from the sum-over-histories formulation. The way in which the commutation properties of operators must be related to the topological properties of many-sheeted histories is brought out. This circumstance stresses the possibility of dispensing altogether with operators and their commutation rules in deriving expressions for expectation values and other observable quantities. On the other hand one is led to the field configuration representation of the operators and states of quantum field theory, which is the analogue of the representation used almost exclusively in particle quantum mechanics. This representation provides explicit wave functionals for the vacuum state and other states of the field, which give certain insights into their character. In particular a straightforward derivation of field fluctuations is obtained. Ideas are proposed which may find application to the problem of strongly coupled fields. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25412 A NEW APPROACH TO THE WIGHTMAN PROGRAM. William Francis Hall. Thesis, Los Angeles, Univ. of California, 1964. 77p.

A new method is developed for dealing with a basic problem in the Wightman formulation of quantum field theory; namely, the incorporation of local commutativity of field operators, together with the mass spectrum condition, in a characterization of the mathematical properties of Wightman functions. These conditions, when placed upon the proper combination of Wightman functions, require that this combination and its Fourier transform vanish in specified domains; the new approach treats these two conditions in a symmetric fashion, thereby achieving a simple statement of the basic problem. A one-dimensional analog of this problem, apparently never considered before, is formulated and solved using well-known techniques. This analog is then used as a device for developing the new approach. Finally, applications of the new approach to the Wightman formulation of quantum field theory are explored. These applications are limited due to the occurrence of certain mathematical problems associated with employing this method. These problems are pointed out and the work done on them to date is summarized. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25413 CORRELATIONS AND EXCITATIONS IN QUANTUM LIQUIDS. David Pines (Univ. of Illinois, Urbana). 47p. (CONF-651-82)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Simple quantum mechanical arguments are used to find precise connections between the correlation functions and the elementary excitation spectra of quantum liquids in the long wavelength limit. For a neutral Bose liquid at $T = 0$ with macroscopic occupation of a single quantum state, and for a neutral Fermi liquid with attractive interactions such that the quasiparticle excitation spectrum shows an energy gap, it is found that the liquid exhibits superfluid behavior, and an expression for the dynamic form factor is obtained. For finite-temperature superfluids, the relation between the two-fluid parameter, the excitation spectrum, and the existence of long-range order is described. Sum rules for Bose liquids are presented and used to place limits on the temperature-dependent velocity of quasiparticle sound in liquid He II. Connections between longitudinal response and the density fluctuation excitation spectrum for a one-component charged quantum liquid are considered briefly. (M.J.T.)

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Refer also to abstracts 25195, 25197, 25216, and 25227.

25414 (NP-14991) VLF PHASE PERTURBATIONS AND THE SOVIET HIGH-ALTITUDE NUCLEAR BURSTS OF OCTOBER 22 AND 28, 1962. 2. COMPARISON WITH SATELLITE PARTICLE DATA. A. J. Zmuda, C. R. Haave, and B. W. Shaw (Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.). [1965]. Contract NOw 62-0604-C. 42p.

Energy and spatial characteristics of artificial radiation belts were deduced in the preceding examination of the temporal histories of the VLF phase perturbations produced by the two Soviet high-altitude nuclear bursts of October 1962. For both bursts the trapped electrons have energies $\lesssim 4$ Mev with the electron spectrum $\lesssim 0.78$ Mev resembling that from the radioactive decay of neutrons. This dichotomy of fission and neutron-decay betas in the electron spectrum has not been achieved in the satellite particle data so far analyzed, where the energy ranges are either too broad or above 0.78 Mev. For the burst of October 22, the VLF characteristic that electrons $\lesssim 4$ Mev are trapped in the region encompassing at least $1.75 \lesssim L \lesssim 3.76$ is compatible with the trapped particle flux observed by Explorer 14, Alouette, and Telstar 1. For the burst of October 28, the VLF shows that fission betas $\gtrsim 0.78$ Mev are not present in $L > 2.32$ and are confined on shells < 2.32. This characteristic agrees with the results for Alouette electrons $\gtrsim 3.9$ Mev but not with the Explorer 14 results for $E > 1.6$ Mev or the Explorer 15 results for

electrons > 1.9 Mev. The Alouette results also show that the energy spectrum extends to about 10 Mev but that there is a rapid decrease in flux for E > 4 Mev. For the burst of October 28 the VLF shows that neutron-decay betas have an outer trapping boundary in $2.32 \leq L \leq 2.79$, which is compatible with the Explorer 14 results for E > 230 kev but not with the Telstar data for E > 390 kev, where the outer boundary extends to L ~ 4. The VLF result that protons $2.3 < E < 4.6$ Mev are trapped in shells < 2.32 complements the Explorer 14 finding that the Soviet bursts produced no discernible changes in the equatorial intensities of protons >500 kev at L = 2.8 and 3.2. The characteristics of protons from nuclear explosions are reviewed and the electron results are consolidated to form at least a model for additional investigations of the artificial radiation belts formed by the Soviet bursts of October 22 and 28 in 1962. (auth)

25415 EAST-WEST MOVEMENTS OF AURORAS AND AZIMUTHS OF QUIESCENT ARCS FROM OBSERVATIONS AT TIXIE BAY. N. I. Dzyubenko (Kiev State Univ.). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 520-5 (1964).

On the basis of photographic observations at Mostakh Island and Tixie Bay, the characteristics of east-west drift of auroras and diurnal changes of the azimuths of quiescent arcs and bands were studied. It is shown that at Mostakh Island before 23 LT a westerly drift of auroras is predominant and after 23 hours is easterly. An estimate of the velocities of drift of diffuse and pulsating patches was made. All the observations apply to the second half of the night. Drift direction in all cases is easterly. The velocities fall in the range 60 to 280 m/sec, with a mean value of 140 m/sec. According to movie films taken with short exposures at Tixie Bay the drift velocities of individual details in active rayed bands fall in the range 0.9 to 7.6 km/sec. The diurnal variation of the azimuths of quiescent arcs was determined from ascafilms for two complete seasons of observations at Mostakh Island. From 18 to 04 LT the azimuths of the arcs, counted to the east of the direction to the north geomagnetic pole, decrease from 100 to 71°. An increase in the azimuths of the arcs begins after 04 LT. (auth)

25416 THE NATURE OF SOME REGULARITIES OF MAGNETIC ACTIVITY. V. M. Mishin and M. L. Platonov (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, Siberian SSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 561-4(1964).

A mechanism is discussed by which the diurnal rotation of the geomagnetic dipole creates the S'(T) component of diurnal variation of magnetic activity. (auth)

25417 SOME ELEMENTS OF THE THEORY OF MAGNETIC STORMS. V. I. Afanas'eva, Yu. D. Kalinin, and E. I. Mogilevskii (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 565-71(1964).

Considerations are shown to indicate that solar corpuscular streams consist of condensations of plasma with a force-free magnetic field. It is shown that 5.5 hours after Mariner 2 recorded a magnetic disturbance, a world-wide disturbance of the same form was noted on the earth. Evidence is presented that for an understanding of the irregular part of the field of magnetic storms it is necessary to take into account the inductance and resistivity of the magnetosphere to the electric current. (auth)

25418 KINEMATIC MODELS OF THE EARTH'S HYDROMAGNETIC DYNAMO. S. I. Braginskii. Geomagnetism Aeronomy (USSR) (English Transl.), 4: 572-83(1964).

Equations of generation were solved for a certain distribution of velocities, which, as might be expected, is similar to the distribution of velocities during convection in the earth's liquid core. The solution derived gives a field corresponding to the actually observed geomagnetic field and makes it possible to explain its principal characteristics. (auth)

25419 ANALYTICAL REPRESENTATION OF SECULAR VARIATION. N. V. Adam, N. P. Ben'kova, V. P. Orlov, N. K. Osipov, and L. O. Tyurmina (Inst. of Mathematics and Computation Center, Academy of Sciences, Siberian SSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 584-7(1964).

The results are described of synthesis of SV (secular variation) using the coefficients of spherical harmonic analyses of two world SV maps for the epoch 1955. The representativeness of synthesis when the length of the harmonic spherical series extends to n = 6 was investigated. The conclusion is drawn that six harmonics are sufficient for representation of the world SV distribution with the same degree of generalization as on world SV maps compiled directly on the basis of observations at magnetic observatories. The possibilities of using the analytical method for compilation of SV maps are pointed out. (auth)

25420 VERTICAL DISTRIBUTION OF THE GEOMAGNETIC FIELD. N. V. Adam, N. P. Ben'kova, V. P. Orlov, N. K. Osipov, and L. O. Tyurmina (Inst. of Mathematics and Computation Center, Academy of Sciences, Siberian SSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 587-93(1964).

A discussion is given of the results of a calculation of the magnetic field at different altitude levels. The calculation was done by the method of spherical harmonic analysis. Maps of the geomagnetic field were constructed for altitudes of 0 and 15,000 km. It is shown that from an altitude of 10,000 km the field can be considered to be a dipole field for the entire earth's surface. Asymmetry of the field was confirmed. Values are given of the dipole and differential vertical gradients, and a comparison is made with gradients obtained from finite differences. (auth)

25421 SPATIAL STRUCTURE OF THE GEOMAGNETIC FIELD AND SOME PROBLEMS INVOLVING THE STUDY OF THE EARTH'S INTERNAL STRUCTURE. [PART] III. I. M. Pudovkin (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Leningrad). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 594-601(1964).

The spatial structure of the Z_{20} field is analyzed. As a result of the analysis, it was found that the South American maximum and the Australian minimum are conjugate points of this field. It is postulated that these conjugate extremes are caused by a single source of the curved horizontal solenoid type, whose center is situated at a depth of 0.25 R. Arguments are advanced that the Bauer residual field is to a considerable degree fictitious. (auth)

25422 DENSITY OF N_2^+ IONS IN HIGH AURORAL RAYS. O. L. Vaysberg and F. K. Shuyskaya (Inst. of Atmospheric Physics, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 610-12(1964)

From March 30 to April 1, 1960, auroras with a very high total brightness were observed, containing long rays, the upper parts of which were reddish. Spectra obtained with a photoelectric spectrometer showed an anomalous intensification of the bands of the first negative system of N_2^+ with a strongly developed rotational and vibrational structure. The heights of rays were determined, and the brightness of individual lines was studied. The results show that a high density of N_2^+ can be observed in individual rays to heights of the order of 1000 km. (D.C.W.)

25423 DETERMINATION OF THE ELECTRON CONCENTRATION PROFILE IN THE LOWER IONOSPHERE FROM THE ABSORPTION FREQUENCY VARIATION. V. V. Belikovich, M. A. Itkins, and L. V. Rodygin (Gorkii State Univ., USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 612-15(1964).

A formula is obtained for determining the electron density profile in the lower ionosphere from measurements of radio wave absorption at several frequencies. (D.C.W.)

25424 FREQUENCY OF APPEARANCE OF ANOMALOUS IONIZATION IN THE F2 LAYER AT HIGH LATITUDES. L. A. Yudovich (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sci-

ences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 615-16(1964).

The frequency of appearance of anomalous ionization with critical frequencies ≥ 5 and 7 Mc was determined both for the entire winter season (1957-1958) and as the mean arithmetical value of four values for each winter month in the Northern and Southern Hemispheres. (D.C.W.)

25425 GEOMAGNETIC CONTROL OF EAST-WEST DRIFT IN THE F REGION OF THE IONOSPHERE. E. S. Kazimirovskii and G. I. Kyun (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, Siberian SSR). Geomagnetism Aeronomy (USSR) (English Transl.), 3: 617-18(1964).

The average diurnal variations of zonal drift were calculated for a number of stations using data for magnetically quiet days only. The results were compared with theoretical predictions. A possible explanation for the discrepancies is the influence of hydromagnetic factors on the parameters of drift in the upper ionosphere. (D.C.W.)

25426 INTERACTION BETWEEN ADVANCING SHOCK WAVES AND STRONG DISCONTINUITIES IN SPACE IN THE EARTH'S NEIGHBORHOOD. K. G. Ivanov (Inst. of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences, USSR). Geomagnetism Aeronomy (USSR) (English Transl.), 4: 626-9(1964).

The effects on a shock wave advancing from space of interactions with a wave receding from the magnetospheric boundary and with the magnetospheric boundary were investigated theoretically. (D.C.W.)

25427 ATTENUATION OF HYDROMAGNETIC WAVES IN THE IONOSPHERE. Syun-Ichi Akasofu (Univ. of Alaska, College). J. Res. Natl. Bur. Std., 69D: 361-6(Mar. 1965).

Effects of the daily variation of the ionosphere on the attenuation of hydromagnetic waves are examined. The ionosphere just before sunrise is almost transparent to the extraordinary component of the waves of frequencies between 10^{-3} and 10^{2}c/s, but becomes fairly opaque during daylight hours. An intense ionization in the E region, namely, the sporadic E, can heavily attenuate the waves of frequencies above 10^{-2}c/s. It is concluded that the daily, latitudinal, and seasonal variations of the ionosphere must be taken into account in order to examine characteristics of the source of geomagnetic micropulsations. (auth)

25428 ANGULAR DEPENDENCE OF THE REFRACTIVE INDEX IN THE IONOSPHERE. Georges A. Deschamps (Univ. of Illinois, Urbana). J. Res. Natl. Bur. Std., 69D: 395-400(Mar. 1965).

The dispersion properties of an anisotropic medium, such as the ionosphere in presence of the earth's magnetic field, are conveniently represented by the variations of the refractive index with the direction of propagation. It is shown that, for a number of cases of practical interest, the variation of the index n with the angle θ takes a special form which can be expressed by a graphical construction: the result n is read on a circular scale, called the index circle, at the points where it is intersected by a straight line which depends in a simple manner on the direction of propagation θ. The same construction applies when the wave is evanescent, and then it gives the imaginary value of the refractive index or extinction index. The range of application of this construction includes the Appleton-Hartree equation, its generalization for any number of ions, the hydromagnetic waves in a medium with finite compressibility, and the various approximations corresponding to limiting or transitional cases– Alfvén waves, uniaxial media, and Booker's hydromagnetic approximation. It could also be applied to magnetized ferrites. For most applications the index circle representation can take the place of the dispersion surface. The main features of this surface— the number of sheets, whether they are real or imaginary, and the direction of the asymptotes— are all displayed on the index circle. If the need arises, it is easy to trace the dispersion surface and to follow its deformations as the parameters of the medium are varied. (auth)

25429 STUDY OF THE PHENOMENON OF WHISTLER ECHOES. T. Laaspere, W. C. Johnson, and J. F. Walkup (Dartmouth Coll., Hanover, N. H.). J. Res. Natl. Bur. Std., 69D: 407-14(Mar. 1965).

In considering the propagation of long whistlers and whistler echo trains, the question arises about where the downcoming whistlers are reflected. The several suggestions that were made include ground reflection and reflection at the lower boundary of the ionosphere. In either case, the echo of a daytime whistler would make several more passes through the absorbing D region than the whistler itself, and we should expect whistlers occurring around noon to have a much smaller probability of having echoes than whistlers occurring at night. An analysis of several years of data obtained at the Dartmouth College whistler station yields the result, however, that although the average whistler rate is much higher at night than during the day, the probability of a whistler having an echo shows little change from midnight to midday. Consistent with this observation are the results of another study showing that the difference in the intensity of a noontime whistler and its echo may be only a few decibels. If the theoretical predictions about absorption of whistler-mode waves are even nearly correct, our results on whistler echoes are incompatible with the lower-boundary or ground-reflection model. In no cases studied by us has the whistler echo been more intense than the whistler itself, and we do not at present favor the idea that whistler echoes are amplified in the magnetosphere. A model consistent with our results is one in which a large fraction of the energy of a downcoming whistler is reflected above D-region heights. In this model a whistler may be pictured as bouncing back and forth between the ionospheres of the two opposite hemispheres, with some of the energy "leaking through" to the ground at one or both ends of the path. Whistler observations could also be explained by a model in which the daytime transmission loss for vlf energy is high only for the first upward penetration of the ionosphere, but small once the energy is propagating in the "whistler mode." (auth)

25430 MULTIPLE-FREQUENCY INVESTIGATIONS OF RADIO WAVE ABSORPTION DURING THE DAWN-BREAKUP PHASE OF AURORAS. R. Parthasarathy and F. T. Berkey (Univ. of Alaska, College). J. Res. Natl. Bur. Std., 69D: 415-21(Mar. 1965).

Multiple-frequency and multiple station radio wave absorption data from the auroral zone are used to investigate the electron density content in the D region during a certain type of absorption events. The type is characterized by smooth variability and widespread geographic extent; the approximate electron density profiles are derived and discussed. The general features of the profiles were found compatible with the ionization due to the high energy electrons and the associated bremsstrahlung x rays. Such events are also discussed in relation to the visual auroral and magnetic records. (auth)

25431 RESEARCH WITHIN THE IONOSPHERE. Robert E. Bourdeau (Goddard Space Flight Center, Greenbelt, Md.). Science, 148: 585-94(Apr. 30, 1965).

Advances in understanding the ionosphere are summarized, with emphasis on those made as a result of rocket and satellite studies. The nature of the neutral atmosphere from which ions and electrons are created is discussed. The dependence on altitude of the temperature and composition of neutral gas in the ionosphere is shown. The D region, which occupies approximately the same altitude interval as the mesosphere, is the lowest region where free electrons are found in significant number. The relative importance of x rays and Lyman alpha radiation in the formation of the normal D region is shown to depend on the level of solar activity. Effects of solar flares and auroras on electron abundance in the D region are discussed. It is shown that at night the D region of ionization essentially disappears, electron abundance in the E region decreases 100-fold, and electron abundance in the upper F region persists strongly. It was found that F-region electrons originate principally through production of O^{+} ions by solar ultraviolet radiation. The dominant process in

the loss of electrons in this region is believed to be radiative recombination. The satellite studies are reviewed. Major results were observations of the effects of latitude and diurnal change on electron behavior in regions above the F2 peak and of electron-density irregularities aligned with the magnetic field. Temperatures of charged particles in the upper ionosphere were measured. (50 references) (M.C.G.)

25432 AIRGLOW. V. I. Krasovskii and N. N. Sefov (Inst. of Atmospheric Physics, Moscow). Space Sci. Rev., 4: 176-98(Mar. 1965).

A review is given of the status of the problem of upper atmospheric emission, in relation to the processes that occur in that region. 88 references. (auth)

25433 EFFECTS OF ELECTROMAGNETIC PERTURBATIONS ON PARTICLES TRAPPED IN THE RADIATION BELTS. J. W. Dungey (Imperial Coll. of Science and Tech., London). Space Sci. Rev., 4: 199-222 (Mar. 1965).

The adiabatic theory of particle trajectories is applied to the radiation belts. The effects of electromagnetic disturbances on the adiabatic invariants are studied. (D.C.W.)

25434 THEORY OF MOVEMENT OF IRREGULARITIES IN THE IONOSPHERE. S. Kato (Kyoto Univ.). Space Sci. Rev., 4: 223-35(Mar. 1965).

Theoretical treatments of the motion, decay, and growth of ionization irregularities in the ionosphere are briefly reviewed and criticized, with consideration of some unsolved problems. (D.C.W.)

25435 THE ASYMMETRIC INTERACTION OF THE MAGNETOSPHERE WITH SOLAR PLASMA. G. L. Pai and V. A. Sarabhai (Physical Research Lab., Ahmedahad, India). p. 43-7 of "International Conference on Cosmic Rays. Vol. 2." Bombay, Tata Inst. of Fundamental Research, 1964.

The times of onset of sudden commencement and gradual commencement storms were studied for seven stations for 1950 to 1961. Implications of the hypothesis that the distribution of onset-time frequencies is due to a longitudinal asymmetry of interaction of the magnetosphere with the solar plasma are examined. (M.J.T.)

Low Temperature Physics

Refer also to abstract 24958.

25436 (RTD-TR-65) ULTRASONIC INVESTIGATION OF MICROSTRUCTURE OF HARD SUPERCONDUCTORS. Progress Report No. 1. Lewis T. Claiborne and Norman G. Einspruch (Texas Instruments, Inc., Dallas). Jan. 1965. 29p.

An ultrasonic investigation of the microstructure of superconducting Nb–Zr alloys was performed. The temperature-dependent ultrasonic absorption peaks in superconducting Nb–Zr depend strongly on the composition and strain content of the individual samples. Pulse echo attenuation measurements at 1.2 to 30°K have been made in samples containing 0.91 to 4.5 at.% of zirconium that have been heat-treated through annealing and quenching and then deformed. In general, annealing reduced the amplitude of the absorption peaks; quenching and deformation increase the amplitude and complexity of the absorption structure. Experiments to determine the effects of trapped magnetic flux and the type II superconducting state on the absorption structure have been performed. To relate the ultrasonic measurements to other properties of the samples, dc measurements of T_c and the resistivity ratios of the various samples were made using a four-point probe technique. At frequencies of 50 Mc/sec and higher, electronic attenuation is large enough to permit measuring T_c and the magnitude of the normal electronic attenuation. Discussion of the experimental data in terms of current theory is presented. (auth)

25437 THE PHYSICS OF SUPERCONDUCTORS OF THE SECOND TYPE. M. B. B. Goodman (Centre de Recherches sur les Tres Basses Temperatures, France). Bull. Soc. Franc. Electriciens (8), 5: 624-9(Oct. 1964). (In French)

The basic factors that determine if a given superconductor belongs to the first or second group are summarized. Since some superconductors of the second type can carry very high current densities ($\approx 10^6$ amp/cm^2) in very intense magnetic fields ($\gtrsim 10^5$ gauss) with almost zero losses, they are of great interest. The laws and the circumstances that govern their electrical and magnetic behavior are examined. (tr-auth)

25438 CRITICAL CURRENT IN SOLENOID IN LOW-FREQUENCY ALTERNATING CURRENT. M. P. Thomas. Bull. Soc. Franc. Electriciens (8), 5: 633-9(Oct. 1964). (In French)

Measurements of critical current in low-frequency alternating current have shown that it was much weaker than in d-c current. A relation of the form $I_c \alpha f^{-1/4}$ for niobium and $I_c \alpha f^{-1/6}$ for niobium–25% zirconium was established. Systematic tests were made to connect this limitation of the critical current to losses in superconductors in alternating fields measured by others. These results show the difficulty of producing a significant alternating field with a superconducting coil. (tr-auth)

25439 PROPAGATION OF THERMAL BLOCKING IN SUPERCONDUCTOR WINDINGS. M. L. Donadieu. Bull. Soc. Franc. Electriciens (8), 5: 644-50(Oct. 1964). (In French)

Thermal blocking is defined as being the macroscopic phenomenon of loss of the superconducting state in a coil traversed by an electric current. This phenomenon is accompanied by various effects: high voltage and elevation of temperature that can impair the superconductor windings. The phenomenon was theoretically studied using an approximate physical model. The laws that govern the phenomenon and especially the time constant characterizing the length were thus established. They were determined experimentally as a function of the current intensity for a series of coils of various sizes and forms. The experimental investigation showed that the physical model gives a valid order of magnitude for the time constant although the theoretical and experimental laws have a certain discord that is explained by numerous approximations of the model. It is also evident that the coppering of the superconducting wire augments considerably the time constant. (tr-auth)

25440 APPLICATIONS OF SUPERCONDUCTORS IN ELECTROTECHNICS. G. Fournet, J. Huret, and A. Mailfert. Bull. Soc. Franc. Electriciens (8), 5: 651-7 (Oct. 1964). (In French)

The applications of superconductors to electrotechnics have been studied at L.C.I.E. for about three years. The results are summarized with a discussion of the general principles and the present state of development. Two particular applications, an alternator and a transformer, are described in more detail. (tr-auth)

25441 SUPERCONDUCTOR QUADRUPOLES. M. J. Favereau and M.-L. Claude. Bull. Soc. Franc. Electriciens (8), 5: 658-62(Oct. 1964). (In French)

Electromagnets, lenses, and classical electromagnetic prisms used in corpuscular physics have a certain number of inconveniences: weight, space occupied, electrical energy consumption, cooling circuits, etc.; the use of superconductors makes it possible to reduce them considerably or even suppress them completely. The high current densities admissible in superconductors permit the realization of current sheets of low thickness very close to the theoretical hypothesis of infinitely thin sheets. A theoretical study was made of quadrupoles, and the principal results are summarized. A small ironless quadrupole was developed and studied experimentally. A description of the quadrupole and some of the experimental results are given. (tr-auth)

25442 LARGE SUPERCONDUCTOR WINDINGS. M. L. Donadieu and M. J. Krikorian. Bull. Soc. Franc. Electriciens (8), 5: 663-8(Oct. 1964). (In French)

The development of large superconductor windings pose

numerous new technological problems: current density, protection of windings, blocking effects (loss of the superconducting state), electrical effects (high voltage), thermal effects (increase of temperature), and cryogenic effects (significant gaseous release). To these is added the cooling of large masses to the temperature of liquid helium (−269°C). These different problems are examined in succession and are discussed in the light of an experimental study based on a series of five Nb−Zr (25%) superconducting coils of increasing size (diameters: 8 to 145 mm). It appears that the current density effectively realizable is subject to a degradation that is poorly known. On the contrary, the protection of windings as the cooling of large masses can be provided reasonably well. (tr-auth)

25443 DEVELOPMENT OF A SUPERCONDUCTOR WINDING OF 100-mm INTERIOR DIAMETER. M. J. Krikorian (Centre d'Etudes Nucleaires, Saclay, France). Bull. Soc. Franc. Electriciens (8), 5: 669-70(Oct. 1964). (In French)

A winding is described that is one of the constituent elements of a magnet destined for the production in air of an axial field with a useful diameter of 66 mm. The magnet is composed of two identical windings arranged approximately in a Helmholtz geometry. The performance of the windings is described. (J.S.R.)

25444 SOME EXPERIMENTS RELATING TO DEGRADATION OF LARGE SUPERCONDUCTING COILS. D. N. Cornish and J. E. C. Williams (United Kingdom Atomic Energy Authority, Culham, Abingdon, Berks, Eng.). Phys. Letters, 16: 18-19(May 1, 1965).

Experiments were performed on different assemblies of main coils and disk coils made from copper plated 0.010 in. $Nb_{75}Zr$ wire. Quenching curves for the disks were found by traversing different load lines, which were selected by choosing various ratios of disk to main coil current, thus carrying out a coil simulation test. The results suggest that degradation is caused by a combination of the quasi-steady field pattern and a flux transient which triggers the quench. (L.B.S.)

25445 DRIFT EFFECT ON MACROSCOPIC FLUX TUBES PROPAGATING IN SUPERCONDUCTORS OF TYPE I. F. Haenssler and L. Rinderer (Universite, Lausanne, Switzerland). Phys. Letters, 16: 29-30(May 1, 1965).

An experiment was performed, using the superconducting powder technique, to observe the motion of flux bundles in circular discs placed in a transverse magnetic field. Niobium powder was spread on indium and tin samples in the superconducting state before the magnetic field was applied. The trajectories observed for moderately pure tin and indium were radial straight lines. In pure indium and tin, a drift effect was observed, which resulted in spiraled trajectories. The drift angle was found to depend strongly on the specimen temperature. (L.B.S.)

25446 LONGITUDINAL AND TRANSVERSE VOLTAGES IN SUPERCONDUCTORS. A. G. Van Vijfeijken and A. K. Niessen (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 16: 23-4(May 1, 1965).

A model is presented for the longitudinal and transverse voltages in type-II superconductors, and expressions are derived for the flow resistivity and the Hall angle. The model clarifies the magnitude of the Magnus force, and the predicted Hall effect is found to be in reasonable agreement with experimental results. (L.B.S.)

25447 OSCILLATORY LONGITUDINAL PARAMAGNETIC EFFECT IN A SUPERCONDUCTING NIOBIUM WIRE CARRYING CURRENT. M. A. R. LeBlanc (Univ. of Southern California, Los Angeles). Phys. Letters, 16: 30-2(May 1, 1965).

Observation of the phenomenon that the magnetization of a magnetically semi-reversible superconducting wire is oscillatory and exhibits paramagnetic maxima as a function of applied magnetic field when a transport current near the corresponding critical value is present are described. (L.B.S.)

25448 SELF-TRAPPED ELECTRONS IN LIQUID HELIUM II. R. C. Clark (Univ. of St. Andrews, St. Andrews, Fife, Scotland). Phys. Letters, 16: 42-3(May 1, 1965).

Computer solutions to the equations given by Gross for the bubble model for the negative ion in liquid helium II, which have to be satisfied by the interacting fields of the electron and boson system, are reported. (L.B.S.)

25449 HIGH-FIELD SUPERCONDUCTIVITY OF CARBIDES. H. J. Fink (Atomics International, Canoga Park, Calif.), A. C. Thorsen, Earl Parker, Victor F. Zackay, and Lou Toth. Phys. Rev., 138: A1170-3(May 17, 1965).

The high-magnetic-field properties of some refractory carbides were investigated at low temperatures. The upper critical fields for NbC, a solid solution of 40% NbC-60% TaC, and TaC are between 4.2 and 21.3 kG; MoC, $Mo_{56}C_{44}$, and $Mo_{60}C_{40}$ + 2% VC have upper critical fields between 80 and 120 kG; and Mo_3Al_2C has an upper critical field of 156 kG at 1.2°K. Mo_3Al_2C is the only known superconductor with the β-Mn crystal structure. From the available data the electronic specific-heat coefficient γ, the thermodynamic critical field H_c, the Ginzburg-Landau parameter κ, and the lower critical field H_{c1} were estimated at the experimental temperatures. (auth)

25450 ON THE MECHANISM OF AMPLIFICATION IN SUPERCONDUCTING FILMS. A. S. Clorfeine (Radio Corp. of America, Princeton, N. J.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 52: 388(Apr. 1965).

It is pointed out that the mechanism proposed by Nethercot, based on thermal effects, for amplification in superconducting films is inapplicable. Evidence is presented supporting an explanation based on parametric action. (D.C.W.)

25451 NUCLEAR SPIN THERMOMETRY BELOW 1°K. R. E. Walstedt (Univ. of California, Berkeley and Oxford Univ.), E. L. Hahn, C. Froidevaux, and E. Geissler. Proc. Roy. Soc. (London), Ser. A, 284: 499-530(Mar. 23, 1965).

A thermometry technique is described, which consists of measuring the magnetization of a system of nuclear spins by means of pulsed nuclear magnetic resonance. Such a thermometer is useful at temperatures below that of pumped liquid helium, which is used as a calibration point. This technique was employed to detect nuclear spin temperatures as low as 10^{-5}°K in a specimen of sodium metal; these temperatures were produced by the well known method of nuclear cooling. The results of the experiments confirm the conclusions drawn by the original authors, namely that, after isentropic demagnetization, the nuclear spins reach temperatures of the order of microdegrees, while the metallic lattice and the conduction electrons remain at the temperature of the cooled paramagnetic salt reservoir. Spin-lattice relaxation times τ_1 were measured for copper metal at temperatures ranging from 0.02 to 0.35°K and for platinum metal at temperatures ranging from 0.05 to 2°K. The copper measurements give $\tau_1 T = 1.2$ sec °K ± 10%, in good agreement with the results obtained by Anderson and Redfield in the temperature range 1 to 4.2°K. An earlier report of an increase in $\tau_1 T$ for platinum by a factor of 2 at temperatures below 1°K is corrected by the present measurements, which show this quantity to be constant at 30 msec °K at temperatures down to 0.07°K. It is further shown that the erroneous earlier measurements were caused by eddy current heating in the metallic specimens. The problem of eddy current heating, which was significant for all of the experiments reported here, is analyzed in some detail. A complete description is given of the electronic circuitry developed for the present low-frequency pulsed nuclear resonance experiments. (auth)

25452 EXPERIMENTS CONCERNING THE EFFECT OF SURFACE CHARGING ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. W. Ruehl (Physikalisch-Technische Bundesanstalt, Brunswick). 6p. (CONF-651-58)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A technique is described for producing a high surface-charge density on metal films, using low-temperature oxidation to create an oxide layer by an electron tunneling mechanism. The shift of superconducting transition temperature in Tl films, caused by the surface charge, was measured as a function of film thickness. (M.J.T.)

25453 QUANTIZED VORTICES IN SUPERCONDUCTORS. R. D. Parks (Univ. of Rochester, N. Y.). 30p. (CONF-651-72)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The Abriksov model for vortex lines in a bulk superconductor is mentioned. The problem of vortices in thin superconductors in a perpendicular magnetic field, for which the nonlinearized Ginzburg-Landau equations have not been solved, is considered. The Tinkham model, treating this problem near T_c, can be used to find that n = 1 is the favored quantum state, but not that quantized vortices actually exist. An experiment was carried out measuring resistivity of superconducting Sn films with plane and line microgeometries; isothermal-resistivity vs magnetic-field transition curves are shown for different temperatures. The problem of inhomogeneity in thin films is discussed; it was solved by developing a microgeometry in which the region examined is so small that the probability of finding an imperfection is nil. Isofield measurements were made to show that the structure observed in the curves is due to free-energy and not induced-voltage effects. The structure is associated with the n = 1 vortices. Effects from interactions between the vortices and the supercurrent at high current densities were studied in a vortex-valve geometry with Sn films; the observation of burst voltages in increasing magnetic fields is described. The dependence of the free energy of a thin superconductor upon its configuration is discussed, for films approximating planes, lines, and points. (M.J.T.)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

25454 (NAA-SR-10899) AN INTRODUCTORY SURVEY OF THERMALIZATION THEORY FOR ZIRCONIUM HYDRIDE. W. J. Roberts (Atomics International, Canoga Park, Calif.). Apr. 20, 1965. Contract AT-11-1-GEN-8. 50p. Dep.; $3.00(cy), 1(mn) CFSTI.

A brief introduction to the main features of the theory of thermal neutron scattering is presented, and the approaches, or models, used specifically for hydrides by various investigators are surveyed. The hydrogen models considered are: (1) the rigid equilibrium point harmonic oscillator model, (2) its variant, the phonon model, and (3) the conduction-state, or periodic-potential wave-state model. (auth)

25455 (ORNL-TM-1087) MEASURED NEUTRON SOURCE SPECTRA FOR ANGULAR SCATTERING EXPERIMENTS WITH SMALL CYLINDERS. J. C. Courtney and V. V. Verbinski (Oak Ridge National Lab., Tenn.). Apr. 9, 1965. Contract [W-7405-eng-26]. 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

In a series of experiments in which the scattering of fast neutrons from small cylinders of various materials was investigated, a pulsed source of bremsstrahlung-produced neutrons was obtained by irradiating a lead target with 14-nsec bursts of 34-Mev electrons from the General Atomic Electron Linear Accelerator. The differential energy spectra of only the source neutrons are presented for the three angles of incidence used. (auth)

25456 (RPI-328-7) GEOMETRICAL TRANSPORT EFFECTS IN THE SPHERICAL HARMONICS APPROXIMATION. T. E. Dudley and P. B. Daitch (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [June 1964]. Contract AT(30-3)-328. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The spherical harmonic approximation is developed in general geometry for the time-independent case with isotropic scattering and source terms. Using the P-3 approximation as an example, it is explicitly shown that the equations and boundary conditions are unambiguously determined in the case of general geometry. The general solution is given. Geometric transients are identified as those solutions of the homogeneous problem with eigenvalues depending only on the mean free path. These transients do not occur in slab geometry, but rather come into the solution as the geometry becomes more complex. The distribution of effort between geometric and material transients as functions of geometry is given on the basis of the spherical harmonics approximation. (auth)

25457 (RPI-328-28) MULTIPLYING MEDIUM ASYMPTOTIC SPECTRUM MEASUREMENTS. R. E. Slovacek, R. J. Cerbone, E. R. Gaerttner, R. R. Fullwood, and D. R. Bach (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1965]. Contract AT(30-3)-328. 27p. (CONF-650504-3; SM-62/65). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany.

The asymptotic (in time) spectrum of a multiplying medium is of interest not only for analyzing pulsed neutron experiments but also for investigating the neutron diffusion properties of the medium. The pulsed neutron source-mechanical chopper technique has been developed to measure the asymptotic neutron spectrum in a multiplying assembly. The surface and center (scalar) spectra were measured for two homogeneous multiplying assemblies and comparisons were made with spectrum calculations. The multiplying systems contained enriched ^{235}U and hydrogen as the moderator in the form of a mixture of UO_2 and ZrO_2 dispersed in paraffin. The center spectrum was calculated by means of a steady-state diffusion theory calculation. The agreement between the measured and calculated spectra was within 5% when a calculated value of the asymptotic decay constant was used to calculate the spectrum. The decay constant calculation took into account the neutron shield region around the medium. The calculated asymptotic spectrum was found to be extremely sensitive to the decay constant; a 7% change in the calculated decay constant for one of the assemblies resulted in a 47% change in the thermal to slowing down flux ratio. Steady state center and surface measurements have also been made in one of the assemblies to compare the two techniques using the same spectrometer. A thermal energy transport calculation of the center and surface steady state spectra agreed to within 20% of the measured spectra. (auth)

25458 (RPI-328-33) THE EFFECTS OF COHERENT SCATTERING ON THE THERMALIZATION OF NEUTRONS IN BERYLLIUM. E. R. Gaerttner, P. B. Daitch, R. R. Fullwood, R. R. Lee, and R. E. Slovacek (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1964]. Contract AT(30-3)-328. 26p. (CONF-650504-6). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany.

Time-dependent neutron energy spectrum measurements were made as a function of time after the initial injection of high energy neutrons into several beryllium assemblies with values of buckling ranging from 0.013 to 0.12 cm^{-2}. In this study, experimental evidence was found of the neutron trapping phenomenon at the Bragg energies of the beryllium. It was found that an asymptotic spectrum was obtained for the smaller bucklings (B^2 = 0.013 and 0.026 cm^{-2}) studied but not in the case of the larger bucklings (B^2 = 0.075 and 0.12 cm^{-2}) for times as long as six thermal mean lives after the initial burst. There is a good measure of agreement with theory in the very asymptotic time range; however, the theory predicts peaking at a very low energy range not reached in these experiments. Detailed time and energy dependent spectrum measurements for four values of buckling are presented. (auth)

25459 THE APPLICATION OF THE METHOD OF MOMENTS FOR RESOLVING THE EQUATION OF NEUTRON THERMALIZATION IN AN INFINITE MEDIUM. M. F. Fedulov. At. Energ. (USSR), 18: 232-8(Mar. 1965). (In Russian)

The application of the method of moments for resolving the equation for neutron thermalization in infinite homogeneous media was investigated, and the results were correlated to the accurate solution for certain cases of thermalization in a monatomic gas. (tr-auth)

25460 SPATIAL DISTRIBUTION OF NEUTRON DOSE SCATTERED IN THE AIR FROM A MONO-DIRECTED POINT SOURCE. S. F. Degtyarev and V. I. Kukhtevich. At. Energ. (USSR), 18: 253-4(Mar. 1965). (In Russian)

Spatial distribution of the $F(R,\theta_0,E_0)$ dose from a point mono-directed Po–Be neutron sources with the initial energy $\bar{E}_0 = 4.2$ and 1.9 Mev, at detector-source distance R = 14.8 m, was investigated. The function $F(R,\theta_0,E_0)$ was determined as a ratio of the scattered radiation dose in a given point to the dosage of a direct emission in a vacuum at the same point. The angle of the θ_0 mono-directed source orientation varied from 20 to 180°. The calculations and experimental data showed that for $(R/\lambda < 1)$, the function $F(R,\theta_0,\bar{E}_0)$ can be approximately expressed as: $F(R,\theta_0,\bar{E}_0) = R\lambda^{-\frac{1}{2}} A(\theta_0,\bar{E}_0)$. It was also found that $A(\theta_0,\bar{E}_0)$ (with the order of accuracy of 15 to 20%) does not depend on E_0 at the energy range 0.33 to 4 Mev and 6 to 14 Mev. The magnitude of $F(R,\theta_0,\bar{E}_0)$ was found with the order of accuracy of ±20%. (R.V.J.)

25461 MEASUREMENTS OF THE MODERATION LENGTH OF Po–Be SOURCE NEUTRONS IN GRAPHITE–WATER LATTICES. Yu. M. Shalashov. At. Energ. (USSR), 18: 282-4(Mar. 1965). (In Russian)

The moderation length of Po–Be source neutrons was measured in two directions ($\tau_{||}$ parallel) and ($\tau_{\perp}$ perpendicular) at the energy of indium resonance absorption (1.46 ev) in a heterogeneous graphite–water system. An indium tracer was used for measuring the relative spatial-distribution of moderated neutrons. The tabulated measurements and calculations for moderated neutrons are in agreement with published data. The distance of neutron moderation was calculated in the age approximation for homogeneous water–graphite mixtures with their nuclear concentration ratio corresponding to the ratio of the investigation lattices and pure moderators. (R.V.J.)

25462 MEASUREMENT OF THE STRENGTH OF A Pu–Be NEUTRON SOURCE. L. Fava, V. Sangiust, and M. Terrani (CESNEF, Milan). Energia Nucl. (Milan), 12: 205-11(Apr. 1965). (In Italian)

The measurement of the strength of a Pu–Be neutron source is described. An absolute measurement and an intercalibration by two different methods with the Ra–Be source of CISE, were performed. The intensity of the Pu–Be source is $(5.24 \pm 0.10) \times 10^6$ n/sec and is in good agreement with the results of the intercalibrations. (auth)

25463 ON THE TRANSFER OF NEUTRONS IN A ONE-DIMENSIONAL STATIONARY CASE. Kh. Khristov and P. Raichev. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 12: 213-29(1964). (In Bulgarian)

The diffusion equation is developed and solved for the one-dimensional stationary case, allowing for anisotropic neutron scattering in the medium. (D.C.W.)

25464 HOW TO COMPUTE NEUTRON TRANSMISSION AND DIFFUSION. [C. W. Tittle]. Nucl.-Chicago Tech. Bull., No. 12, 5p.

The application of elementary diffusion theory to the transmission of neutrons through matter is discussed. Considerations were restricted to homogeneous media without boundaries, containing a point source of neutrons. Topics discussed include: fast neutron transmission in good geometry experiments, mean square distance of a distribution, the slowing down of neutrons, diffusion theory, multigroup diffusion theory, evaluation of diffusion constants, comparison of diffusion theory with experiment, effective energy of thermal neutrons, and boundary conditions. (M.C.G.)

25465 ATOMICS INTERNATIONAL AUTOMATED CROSS-SECTION PROGRAM. Harry Alter and Henry J. Lorenzi (Atomics International, Canoga Park, Calif.). 50p. (CONF-654-44)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The objectives and general organization of the Cross-Section Program are discussed, including methods for literature searching, data analysis and compilation, and production of multigroup libraries and engineering tapes. Elements and isotopes for which data are available are listed. The computer programs for manipulating the data—MOMUS, GRAVE, and PRISM, in Fortran for IBM 7094—are briefly described. Results of a sample calculation, 18-group data for ^{27}Al, are presented. (M.J.T.)

25466 METHOD OF GENERATING PULSED NEUTRON BEAMS. (to Tokyo Shibaura Electric Co., Ltd.). British Patent 976,770. Dec. 2, 1964. Priority date Dec. 5, 1961, Japan.

A method and apparatus are described for the production of pulsed neutron beams whereby a first pulsed voltage is applied to the source, i.e. a deuterium ion source, to cause the emission of ion pulses toward a neutron-emissive target through a slit. A deflector electrode is arranged to deflect the ion pulses so as not to pass through the slit to the target, and means are provided for applying a further pulse voltage of narrower pulse width than the first to the deflector electrode. The second pulse voltage is applied to the first pulsed voltage so as to nullify the defecting effect of the electrode to permit an ion pulse of relatively narrow width to pass through the slit to the target. (B.L.M.)

25467 IMPROVEMENTS TO NEUTRON GENERATORS. James David London Hedley Wood and Peter Donald Lomer (to United Kingdom Atomic Energy Authority). British Patent 978,521. Dec. 23, 1964. Filed June 28, 1962.

Improvements to neutron generators of the type in which an ion source generates ions that are accelerated across an acceleration gap by a potential difference applied across the gap so as to strike a target material with high energy are described. The target is located in a field-free zone behind an electrode forming one side of the gap, and the field-free zone also embraces an α-particle detector located in a side-arm of the sealed envelope and mounted in direct view of the target but located outside the path of the ion beam to detect α-particles emitted from the target. Due to these improvements Paschen breakdown between the α counter and the ion source is prevented, and secondary electrons given off by the target cannot attain full acceleration potential and impinge on the counter. (B.L.M.)

Nuclear Properties and Reactions

Refer also to abstracts 24611, 24751, 25089, 25143, 25176, and 25696.

25468 (ARF-1193-17) SCINTILLATION SPECTROMETER MEASUREMENTS OF CAPTURE GAMMA RAYS FROM NATURAL ELEMENTS. Period Covered: June 15–October 31, 1962. (Armour Research Foundation, Chicago, Ill.). Dec. 26, 1962. Contract AT(11-1)-578. 91p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

The objective of this program is to make a compilation of thermal neutron capture gamma ray spectra of naturally occurring elements, in both the low- and the high-energy spectral regions, using NaI(Tl) scintillation crystals as detectors. The principal effort was expended in obtaining both low- and high-energy neutron capture gamma ray spectra of a suitable quality for inclusion in the Atlas. Specifically, low-energy neutron capture gamma ray spectra of chromium, germanium, molybdenum, ruthenium, palladium, antimony, tellurium, hafnium, platinum, and thallium were obtained using a 3 in. × 3 in. NaI(Tl) detector, while the low-energy spectra of gallium and iridium were obtained with both a 1½ in. × 1 in. and the 3 in. × 3 in. NaI(Tl) detectors. High-energy capture gamma ray spectra of nickel, yttrium, dysprosium, lutetium, tungsten, and mercury were also obtained using the 3 in. × 3 in. NaI(Tl) scin-

tillation spectrometer. In addition to the accumulation of these spectra, subsidiary experiments were conducted with the 1½ in. × 1 in. and the 3 in. × 3 in. NaI(Tl) crystals to obtain data necessary for the analysis of the low-energy spectral data to obtain absolute capture gamma ray intensities; for example, experiments were performed to obtain the "Peak to Total" ratios of these crystals and to determine quantitatively how the detector shielding assembly modified the spectral shapes of monoenergetic gamma rays of various energies. (D.L.C.)

25469 (CAR-882-9) STUDY OF THE DEPOLARIZATION OF NEGATIVE MUONS IN LIQUID HELIUM. John Kane (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Physics). May 1964. Contract AT(30-1)-882. 79p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The ground state polarization was determined for μ^--mesons stopping in nuclear spin zero targets of liquid helium, liquid argon, and carbon. A precessional technique was employed, allowing $(\mu - e)$ decay anisotropy to be observed in terms of the sinusoidally modulated decay distribution $N_0 e^{-\lambda_T t}\,[1 + A \cos(\omega^t - \overline{\varphi})] + B_0$. An analysis of the data over one or more precession cycles was made by means of a least-squares procedure, with the results being corrected for the finite geometry used. In contrast to carbon, which under different conditions yielded asymmetry coefficients of $a = -0.052 \pm 0.004$ and $a = -0.040 \pm 0.010$, both helium and argon demonstrated asymmetry values consistent with total depolarization. This indicates a deviation from the pattern of large asymmetry established in a number of other spin-zero nuclei. (auth)

25470 (HW-84369(p.37-8)) NOTE ABOUT THE BETA-RAY SPECTRUM OF Lu^{176m}. L. C. Schmid (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results obtained in measurements of maximum energies and intensities of beta particles emitted in ^{176m}Lu decay are summarized. (J.R.D.)

25471 (JINR-P-2025) TROINOE DELENIE U^{235} NA REZONANSNYKH NEITRONAKH. (Triple Fission of ^{235}U With Resonance Neutrons). I. Kvitek, Yu. P. Popov, and Yu. V. Ryabov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 9p. (CONF-650301-15). Dep.(mn).

From Symposium on the Physics and Chemistry of Fission, Salzburg, Austria.

The ratio of ternary and binary fission of ^{235}U by monochromatic neutrons in the energy range 0.1 to 50 ev was measured. The ternary fission was identified by coincidences of fission fragments with an α particle which eliminated the possible influence of α particles from ^{235}U (n,α) reaction on the obtained results. (R.V.J.)

25472 (KAPL-M-6424) MULE — A PROGRAM FOR MULTI-LEVEL, MULTICHANNEL CALCULATION OF NEUTRON CROSS SECTIONS WITH DOPPLER AND RESOLUTION BROADENING. E. J. Brooks, Jr., and E. L. Slaggie (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1964. Contract W-31-109-eng-52. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Neutron fission, scattering, and capture cross sections can be calculated from R-matrix theory in an approximation involving many levels and channels. MULE is a Philco-2000 transcription of MULTILEVEL FIT, an ORNL program for the IBM 704, which performs such calculations. Some R-matrix theory results are summarized, in addition to a description of the program input and the program logic. Also described are program options permitting Doppler and resolution broadening of the cross sections. (auth)

25473 (LYCEN/6416/1) RAPPORT BIBLIOGRAPHIQUE CONCERNANT LES REACTIONS $A(\alpha, \ldots)B$ POUR DES ENERGIES INCIDENTES SUPERIEURES A 20 Mev. (Bibliographic Report on $A(\alpha, \ldots)B$ Reactions for Incident Energies Above 20 Mev). J. Bougnot and P. Gaillard (Lyon Univ. (France). Institut de Physique Nucleaire). July 22, 1964. 49p. Dep.(mn).

A bibliographic study was made of the elastic and inelastic scattering of α particles having an incident energy higher than 20 Mev, and (α,d), (α,p), (α,n), and (α,xn,yp) reactions. 128 references. (J.S.R.)

25474 (NP-15007) HIGH-ENERGY INELASTIC ELECTRON SCATTERING BY OXYGEN 16. Leon Gruenbaum (Max-Planck-Institut fur Physik und Astrophysik, Munich (West Germany) and Technische Hochschule, Munich (West Germany)). [1963]. 44p. Dep.(mn).

The experimental form factors for inelastic scattering of electrons from oxygen ^{16}O are compared with the theoretical form factors in order to obtain direct information about the nuclear wave functions with particle-hole configuration mixing without ground state correlations. The levels of odd parity agree well with the experimental results. In most cases, the inelastic form factors depend little on the average nuclear potential but strongly on the configuration amplitude. The γ decay width to the ground state depends on the average potential. On the other hand it is possible to distinguish between collective excitations and single particle excitations from the different behavior of longitudinal and transverse form factors. Sum rules for γ-absorption are also studied. (auth)

25475 (ORNL-TM-1044) SOME RECENT NUCLEAR CROSS SECTION MEASUREMENTS AT ORNL, OCTOBER 1, 1964–JANUARY 31, 1965. P. H. Stelson (Oak Ridge National Lab., Tenn.). Feb. 17, 1965. Contract [W-7405-eng-26]. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Research is reported on charged particle cross sections, fission cross sections, ^{16}O total cross sections at 3.77 Mev, inelastic neutron scattering, excitation in inelastic neutron scattering, total cross sections of C and H at 20 to 30 Mev, resonances in ^{204}Pb + n, stopping powers of elements for ions, Coulomb excitation of Cd and Ag nuclei, levels and s-wave neutron strengths of hafnium isotopes, neutron capture, isobaric states in ^{90}Zr, ^{116}Sb, ^{118}Sb, and ^{120}Sb, neutron yields from $^{14}C(\alpha,n)^{17}O$, energy levels of ^{75}As, cross sections of ^{50}V, gamma spectra in ^{19}F neutron capture, and measurement of neutron capture gamma rays. (J.R.D.)

25476 (TID-21525) NUCLEAR CHEMISTRY RESEARCH. A. CHARGE STATES OF CARBON AND BORON RECOILS. B. ISOMERIC YIELD RATIOS. C. EXCITATION FUNCTIONS. D. DENSITOMETRIC DETERMINATION OF CONVERSION ELECTRON LINE INTENSITIES. Annual Report, January 1964–January 1965. Robert L. Wolke (Wherrett Lab. of Nuclear Chemistry, Univ. of Pittsburgh, Pa.). Contract AT(30-1)-2771. 59p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Equilibrium charge state measurements were made at 6.2 Mev for ^{12}C ions and at 6 Mev for ^{10}B ions produced in (d,d') and (d,α) reactions. The charge spectrum and relative abundances from these reactions are presented graphically. Data on the stripping of C isotope ions as a function of velocity are given. Data are also included on the ionization potentials(I) for the six electrons in C and the ionic velocities (V) which relate to these potentials through the equation $V^2 = 2I_n/m_o$. Comparisons are presented showing that Lamb's theory does not predict the charge of a C at a specified velocity, however, it appears adequate for predicting the approximate magnitude of the mean charge. Other theoretical aspects of equilibrium charge states are presented. Work was also continued on solving the problems involved in determining pre-equilibrium charge states of C recoils. Work was continued on measurement and interpretation of absolute cross sections and isomeric yield ratios for (d,p) reactions leading to energy level data on ^{60}Co, ^{104}Rh, ^{111}Pd, ^{115}Cd, ^{134}Cs, ^{182}Ta, ^{188}Re, and ^{197}Pt. Deuteron reactions (d,n) leading to energy level data on ^{93}Tc and ^{95}Nb were also studied along with the (d,α) reaction on ^{71}Ga producing ^{69}Zn. Data on radiative deuteron capture in ^{30}Si and ^{138}Ba are included along with cross section values for (d,n) and (d,2n) reactions on ^{110}Pd, ^{186}W, and ^{133}Cs. Excitation functions on the deuteron reactions $^{59}Co(d,t)^{58}Co$, $^{59}Co(d,\alpha p)^{56}Mn$, and $^{133}Cs(d,t)^{132}Cs$ were also obtained. Efforts to develop and standardize quantitative methods for determining K/L or L/M ratios in conversion

electron spectra by film densitometry are described. (J.R.D.)

25477 A SCATTERING-CHAMBER EXPERIMENT FOR THE MODERN PHYSICS LABORATORY. Jerome L. Duggan (Oak Ridge Inst. of Nuclear Studies, Tenn.). Am. J. Phys., 33: 312-18(Apr. 1965).

Many Van de Graaff accelerator-type experiments can be performed at modest and even low bombarding energies. In general, for incident particle energies below 150 kev, one is restricted to proton- or dueteron-induced reactions on light target nuclei. This restriction is, of course, due to the Coulomb barrier for most reactions in this energy interval. Several reactions which are feasible with existing equipment found in many universities throughout the United States and foreign countries are discussed. Necessary modifications to existing Cockcroft–Walton-type accelerators are outlined, and the general experimental procedures for reactions of the type $^{12}C(p,p)^{12}C$ and $^{11}B(p,\alpha)^{8}Be$ are given. (auth)

25478 STUDIES OF MANY-CHANNEL SCATTERING. III. COMPARISON WITH R-MATRIX THEORY. C. Mahaux (Universite, Liege) and Hans A. Weidenmueller. Ann. Phys. (N. Y.), 32: 259-76(Apr. 1965).

The implications and the conditions of validity of the single-level approximation of R-matrix theory are investigated. A comparison is carried through between this theory and S-matrix theory, using results obtained earlier for an exactly soluble case of many-channel scattering. In contrast to the single-channel case, it is characteristic of the many-channel problem that the single-level approximation for the R-matrix is valid under very restricted conditions only. These conditions require a specific choice of the boundary condition parameters B_j, sufficiently large values of the channel radii a_j for the closed channels, and a selection among the set of eigenvalues E_λ determined by these parameters. (auth)

25479 ANGULAR DISTRIBUTIONS OF ALPHA PARTICLES FROM THE NUCLEAR REACTION $F^{19}(p,\alpha\gamma)O^{16}$. Lars Ask. Arkiv Fysik, 29: 195-235(1965).

Measurements were made at thirteen proton energies between 873 kev and 2.63 Mev both at the most prominent resonances and at some intermediate energies. The alpha particles were detected at angles from 20 to 160° with a semiconductor detector of surface-barrier type. Alpha particle energies range from 1.25 to 4.25 Mev. The yield of the reaction was determined by measurement of the corresponding total gamma radiation, and resonance parameters were calculated. The measured angular distributions were analyzed, using the method employing population parameters. Spin, parity, population probabilities for the magnetic substates and orbital mixing parameters were assigned to the levels at 873, 1348, 1375 kev, 1.69 Mev (2^-) and 935 kev (1^+). For the resonance at 1.95 Mev, the spin value 1^+ is suggested, and for that a 2.03 Mev, 2^- is proposed. At the higher energies, interference between neighboring levels was considered. There are indications of the existence of broad levels with spin and parity values 1^+, 2^- and 3^+ above 2 Mev. The possibility of the occurrence of heavy particle stripping is discussed. (auth)

25480 ON THE DURATION OF γ QUANTUM EMISSION DURING FISSION. G. V. Valskii, D. M. Kaminker, G. A. Petrov, and L. A. Popenko. At. Energ. (USSR), 18: 223-6(Mar. 1965). (In Russian)

The duration of γ emission from ^{235}U fission by thermal neutrons was measured using the method of geometric separation of fission fragment trajectory sections. Coincidences of fragments and fission γ quanta were recorded as functions of the distance between the collimator axis and the target. In contrast to the previous data it is shown that during the fission the main mass of γ emission is emitted in less than 5×10^{11} sec. It was also shown that not more than 5 to 10% of γ emission, accompanying the fission, is emitted during the interval of 3×10^{-10} to 2×10^{-9} sec. (tr-auth)

25481 SPATIAL AND ENERGY DISTRIBUTION OF SCATTERED γ EMISSION FROM A MONO-DIRECT SOURCE IN AN INFINITE AIR MEDIA. S. M. Ermakov, V. G. Zolotukhim, V. I. Kukhtevich, E. S. Matusevich, and B. A. Efimenko. At. Energ. (USSR), 18: 251-2(Mar. 1965). (In Russian)

Gamma radiation scattering field was measured experimentally and by the Monte Carlo method. Energy distributions $\phi(E,R,\theta_0)$ were calculated for angles of 2 to 180° (for 10 values). The magnitude of the function $\phi(E,R,\theta_0)$ at the detector-source distance of R = 16 m was calculated at the initial energies (E_0 = 0.5, 1.25, 3.0, and 7.0 Mev. At E_0 = 1.25 Mev $\phi(E,R,\theta_0)$ function was calculated for R equal to 5, 15, and 30 m. At R = 16 m the function was measured for E_0 = 1.25 Mev (with ^{60}Co source) and θ_0 angles at 60, 90, 120, and 150°. The contribution of annihilation radiation was calculated analytically. For R = 16 m, E_0 = 7 Mev, and θ_0 = 180° the contribution of annihilation quanta is twice as high as the contribution of scattered radiation and for the isotropic source (E_0 = 7 Mev) the annihilation emission increased the dosage by 12%. (R.V.J.)

25482 ANGULAR AND ENERGY DISTRIBUTION OF γ-EMISSION SCATTERED NEAR AN ISOTROPIC SOURCE NEAR AN INFINITE AIR MEDIA. Yu. I. Kolevatov, V. I. Kukhtevich, E. S. Matusevich, and O. A. Trykov. At. Energ. (USSR), 18: 252-3(Mar. 1965). (In Russian)

Investigations were made of the angular and energy distribution of scattered γ quanta $\phi(E,R,\theta)$ from a ^{60}Co point isotropic source. The measurements were made in an infinite air media at 15 and 30 m source-detector distance for variable angles θ between the direction of the source-detector and the mono-directed detector symmetry axis ($12 \leq \theta \leq 180°$). The curves for $\phi(E,R,\theta)$ measurements at R = 15 and 30 m indicate the maximum at 0.20 to 0.22 Mev, corresponding to the γ quantum single-scattered at angles near 180°. The graphs for angular distribution of γ-scattered dosage calculations using the energy distribution of $\phi(E,R,\theta)$ at R = 15 and 30 m showed that the relative contribution of multiple-scattered γ radiation to the total dosage is equal to the linear function of angle θ, and reaches the maximum value of ~50% at θ = 180°. (R.V.J.)

25483 TOTAL CROSS SECTIONS OF NEUTRON REACTIONS WITH BENZENE, TOLUENE, AND SODIUM ACETATE AT ENERGY RANGE FROM 0.03 TO 0.5 ev. I. S. Anisimov, V. I. Nikitin, A. I. Saukov, and A. A. Ugodenko. At. Energ. (USSR), 18: 277-8(Mar. 1965). (In Russian)

The influence of the chemical bond of hydrogen atoms on neutron delaying process was studied by measuring the total cross sections of neutron reactions with benzene, toluene, and sodium acetates of energies from 0.03 to 0.5 ev. A reaction T(d,n)^{4}He in a pulsed acceleration tube tritium target was used as a neutron source. The cross section ratio of bound and free hydrogen was plotted as a function of the initial neutron energy. It was assumed that the mean energy losses at ΔE scattering are identical to the losses at scattering angles close to 90°. The mean neutron energy losses in reactions with toluene, benzene, and sodium acetate were measured using the published data on the energy losses in H_2O (at θ = 90° and E = 0.059, 0.09, and 0.117 ev) and considering that $(\Delta E/E) \rightarrow 0.5$ at $E \rightarrow 1$ ev; $(\Delta E/E) \rightarrow 0$ at $E \rightarrow 0.025$ ev. (R.V.J.)

25484 EFFECTS OF RESONANCE CROSS SECTION STRUCTURE ON THE ANISOTROPY OF SCATTERED FAST NEUTRONS AND THEIR PASSAGE IN IRON. A. P. Suvorov, A. G. Guseinov, and M. N. Nikolaev. At. Energ. (USSR), 18: 278-82(Mar. 1965). (In Russian)

Effects of resonance cross section structure of fast neutron diffusion in iron were studied using a multilayer ionization fission chamber with ^{232}Th (effective threshold sensitivity of ~1.5 Mev). The chamber was placed 24 cm from the diffuser with the tracer at an arbitrary angle to the beam axis and angular resolution of $\Delta\theta \leq \pm 9°$, an iron disc placed at 45° to the neutron beam axis was used as a diffuser. Differential cross sections showed an angular

divergence at various thicknesses. The tabulated experimental and theoretical data for E > 1.5 Mev neutron cross sections showed that the resonance screening of angular distribution reduced by about 25% the anisotropy of iron scattered fast neutrons. (R.V.J.)

25485 METHOD FOR STUDYING γ-EMISSION IN (n,γ) REACTION ON SEPARATE ISOTOPES. E. A. Rudak and E. I. Firsov. At. Energ. (USSR), 18: 285-7(Mar. 1965). (In Russian)

Studies of γ emission in (n,γ) reaction on various isotopes were carried out in a tangential reactor column using a Compton spectrometer with a resolving power of 2% and measuring minimum of 0.3 Mev. The specimen in a graphite container was placed opposite from the center of the active zone in a reactor where a flux of thermal neutrons was about 3×10^{12} n/cm² sec. The γ beam of the specimen was collimated by a system of lead collimators and extracted from the reactor channel to the Compton spectrometer radiator. The distance between the specimen and spectrometer radiator was 4.5 cm. The recoil electrons knocked out from the radiator within 1° from the incident beam were captured by a magnetic field on the orbit and momentum analyzed. (R.V.J.)

25486 CALCULATIONS OF EFFECTIVE RESONANCE INTEGRAL BLOCK CONSISTING OF MIXED NUCLEI OF RESONANCE ABSORBER AND ABSORBER WITH SMOOTH CROSS SECTION. Yu. G. Pashkin and V. V. Chekunov. At. Energ. (USSR), 18: 290-2(Mar. 1965). (In Russian)

Formulas were developed for calculation of effective resonance integral of nuclei considering the screening effect produced by nuclei with a smooth absorption cross section. The ratio of effective resonance integral K calculated for two resonances of ^{177}Hf in cylindrical, 10 mm in diameter (11.2 g/cm³ density) hafnium diboride HfB_2 was: E_0 = 1.095 and 2.38 ev, $\sigma_{z_0} = 3.01 \times 10^4$ and 6.8×10^4, and K = 0.284 and 0.338. (R.V.J.)

25487 RADIOACTIVE DECAY OF Cd^{115m}. V. V. G. Sastry, V. Lakshminarayan, and Swami Jnanananda (Andhra Univ., Waltair). Indian J. Pure Appl. Phys., 3: 128-30 (Apr. 1965).

A 4π sum peak coincidence scintillation spectrometer was assembled and employed for studies on the radioactive decay of ^{115m}Cd. The results of the study confirmed the energy levels in ^{115}In at 650, 1125, and 1560 kev. suggested by recent studies. The fractional intensities of gamma transitions involved were measured and compared with the theoretical values computed on the basis of single-particle and core-excitation models. It was concluded that though the application of the core excitation model to the ^{115}In nucleus appears to be reasonable, further experimental data are required for rigorous quantitative comparison of the results. (auth)

25488 MOMENTUM DISTRIBUTION OF NEUTRINOS PRODUCED BY TARGET IRRADIATION WITH NUCLEONS OR NUCLEI. Kh. Khristov and D. Fakirov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 12: 231-6(1964). (In Bulgarian)

The momentum distribution of neutrinos obtained by target irradiation with fixed-momentum nucleons or nuclei is established. In such cases, the target contains a definite type of nuclei. Landau's theory (multiple production of particles in high-energy particle collision) giving the energy and angle distribution of mesons(π) is used. The formula obtained for the density of neutrinos with fixed momentum may be useful in neutrino tests. (auth)

25489 SPACE AND MOMENTUM DISTRIBUTION OF NEUTRINOS OBTAINED BY TARGET IRRADIATION WITH NUCLEONS AND NUCLEI. Kh. Kristov and D. Fakirov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 12: 237-43 (1964). (In Bulgarian)

The momentum and spatial distributions of neutrinos from the decay of mesons(π) produced in target irradiation with high-energy particles are calculated, assuming that the mesons(π) are produced and scattered according to the mechanism proposed in Landau's theory of multiple production. (D.C.W.)

25490 ON THE USE OF OVERHAUSER EFFECTS TO STUDY NUCLEAR MAGNETIC RELAXATION BY SPIN-ROTATIONAL INTERACTIONS. Paul S. Hubbard (Oxford Univ.). J. Chem. Phys., 42: 3546-8(May 15, 1965).

It is shown that the contributions of spin-rotational and dipole–dipole interactions to the nuclear magnetic relaxation of liquid samples containing two different kinds of spin-½ nuclei can be determined from the results of measurements made at a single temperature of the transient and steady-state Overhauser effects and the relaxation rates of each kind of nucleus. (auth)

25491 HOW TO APPLY STATISTICS TO NUCLEAR MEASUREMENTS. [C. W. Tittle]. Nucl.-Chicago Tech Bull., No. 14, 4p.

Poisson statistics in the counting of nuclear events are discussed. The normal distribution is also considered. The chi-square test of goodness of fit is described. Propagation of errors, dead time losses, the most efficient distribution of sample and background counting times, the error of a count rate meter reading, and the case of a decaying source are discussed. A nomogram for estimation of the Poisson counting error and Chauvenet's criterion for rejecting a reading are given. (M.C.G.)

25492 THEORY OF NUCLEAR REACTIONS. VII. PHOTON CHANNELS C. Mahaux (Universite, Liege). Nucl. Phys., 68: 481-503(July 1965).

The theory of nuclear reactions developed previously is extended to the subspace of photon channels. The collision matrix is defined, and its general properties are given. In the framework of first order perturbation theory, it is shown that the collision matrix is meromorphic in the region of physical interest surrouding the positive real axis in the physical ℓ-plane. The elements of the collision matrix are expanded as a series of resonant terms plus a smoothly varying background function, the low energy behavior being accounted for by the introduction of suitable "penetration factors". (auth)

25493 THE DECAY OF Cd^{117} AND Cd^{117m} AND DIRECTIONAL CORRELATION OF GAMMA RAYS IN In^{117}. R. V. Mancuso and R. G. Arns (State Univ. of New York, Buffalo). Nucl. Phys., 68: 504-12(July 1965).

The gamma rays of ^{117}In, following the beta decay of ^{117}Cd and ^{117m}Cd were studied with a scintillation coincidence spectrometer. The prominent energy levels are 310, 400, 590, 745, 860, 1070, 1710, 1880, 1975, 2120, and 2320 kev. The directional correlation functions for the 345 kev–90 kev and 1290 kev–280 kev cascades in ^{117}In were measured. A spin of 3/2 was assigned to the 400- and 590-kev levels. Possible spins for the 745-kev level are 1/2, 3/2, 5/2 and for the 1880-kev level the spins may be 1/2 or 3/2. The experimental level structure is compared with the theoretical predictions. (auth)

25494 DIRECTIONAL CORRELATION OF GAMMA RAYS IN Sn^{117}. R. V. Mancuso and R. G. Arns (State Univ. of New York, Buffalo). Nucl. Phys., 68: 513-16(July 1965).

The gamma-gamma directional correlation function for the 560 kev–160 kev cascade in ^{117}Sn was measured. The experimental expansion coefficients were found to be $A_2 = -0.043 \pm 0.006$ and $A_4 = 0$. A unique spin assignment of 1/2, 3/2, 1/2 was made for the 720-kev, 160-kev levels, and ground state, respectively. The 560-kev transition is pure E2 while the 160-kev transition is M1 + E2 with an E2 content of 1.2 ± 0.5%. The experimental data are compared with theoretical predictions. (auth)

25495 K AUGER SPECTRA AND ATOMIC LEVEL WIDTHS OF Yb (Z = 70). Geoffrey Kaye (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 68: 529-45(July 1965).

The K–LL Auger spectrum of Yb observed in the electron capture decay of ^{171}Lu and ^{172}Lu was studied with the Chalk River $\pi\sqrt{2}$ β-ray spectrometer at an instrumental resolution of 0.06% in momentum. The $K-L_IL_{III}$ $(^3P_1)$ line

and its nearby satellite K–$L_I L_{III}$ ($^3P_2$) were resolved. A comparison was made of the measured line energies with the nonrelativistic theoretical predictions of Asaad and Burhop as modified by Hörnfeldt. Except for the K–$L_{II}L_{II}$ line the overall agreement is better than 3 parts in 10^4. A comparison of the measured relative intensities and the relativistic calculations of Listengarten was also made. Although these predicted intensities are in much better agreement with the experimental data than the non-relativistic calculations of Asaad and Burhop, the agreement is still only qualitative. A curve folding technique was used to determine the natural widths of atomic states in Yb from the measured shapes of low energy internal conversion lines. The measured values of the widths of atomic states characterized by a vacancy in either the K, L_I, L_{II} or L_{III} shells are 32, 5.0, 4.0, and 5.0 ev, with an uncertainty of $\approx 20\%$. (auth)

25496 OBSERVATION OF (n,He^3) REACTION. J. Csikai and A. Szalay (ATOMKI, Debrecen, Hungary). Nucl. Phys., 68: 546-8(July 1965).

The existence of a nuclear reaction of the type (n,^{3}He) was verified by bombarding ^{133}Cs with 14-Mev neutrons. Chemical separation techniques enabled the measurement of the weak ^{131}I activity belonging to this reaction. The comparison of its yield to the yield of ^{130}I produced in the (n,^{4}He) reaction permitted the determination of the ratio of the cross sections. The ratio of the cross sections of the (n,^{3}He) and (n,^{4}He) nuclear reactions was found to be $5 \pm 3 \times 10^{-3}$. Accepting 1.0 mb for the (n,^{4}He) reaction the cross section of the (n,^{3}He) is 5 ± 3 μb. (auth)

25497 MOST PROBABLE VALUES OF THE STRENGTH FUNCTIONS OF NUCLEI. H. V. Muradyan and Yu. V. Adamchuk (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 68: 549-60(July 1965).

A method is described for determining the most probable values of the nuclear strength functions $S = \overline{\Gamma_n^0}/D$, reduced neutron widths $\overline{\Gamma_n^0}$ and average level spacings D. Graphs are given for the maximum likelihood of the strength function in the case of limited statistics, probabilities for the deviation from it and in general the probability for the occurrence of any value of S. It is shown that the available experimental data on the strength functions are insufficient to draw a conclusion on the difference between the strength functions for two spin systems within one nucleus. The maximum likelihood of the optical model parameters can be obtained with the aid of the nuclear strength function distributions obtained. (auth)

25498 THE EXCITED STATES OF THE ODD NUCLEUS La^{140} POPULATED BY THE BETA DECAY OF Ba^{140}. J. Burde, M. Rakavy, and G. Adam (Hebrew Univ., Jerusalem). Nucl. Phys., 68: 561-74(July 1965).

Coincidence measurements between γ rays and conversion electrons and between β rays and conversion electrons verify the existence of the 43- and 580-kev levels in the odd nucleus ^{140}La. By delayed coincidence techniques the mean lifetime of the 43-kev level was determined as $\tau = (7.5 \pm 2) \times 10^{-10}$ sec and the upper limits for the mean lifetime of the levels 466, 162, and 29.6 kev were found to be $\tau \leq 1.1 \times 10^{-11}$ sec, $\tau \leq 1.5 \times 10^{-11}$ sec, and $\tau \leq 6 \times 10^{-10}$ sec, respectively. The γ–γ angular correlation of the (304–162)-kev cascade yielded the result: $W(\theta) = 1 + (0.055 \pm 0.01)P_2(\cos\theta) - (0.009 \pm 0.015)P_4(\cos\theta)$. The 29.6, 13.3, 132 and 162 kev transitions were found to have M1 multipolarities with very low limits for E2 admixture. The results are consistent with the spin assignments of 3^-, 2^-, 1^-, 2^-, 1^-, and (0^-) for the ground state, 29.6-, 43-, 162-, 466-and 580-kev levels, respectively. Comparison was made between the observed transition probabilities and those derived from shell model calculations in terms of coupling between the odd neutron and odd proton. (auth)

25499 A SYSTEMATIC STUDY OF HYPERNUCLEI FROM Σ^- CAPTURES IN NUCLEAR EMULSIONS. A. G. Frodesen, T. Roee and O. Skjeggestad (Universitet, Oslo). Nucl. Phys., 68: 575-81(July 1965).

A total of 35 hypernuclei produced by stopping Σ^- hyperons in nuclear emulsions was studied with main emphasis on the identification problem. A kinematical analysis of the hypernucleus production and decay stars was combined with mass and charge determination of individual prongs. Out of 25 non-mesic hypernuclie, 8 could be uniquely identified and 4 assigned a unique charge. All 10 mesic decays could be uniquely identified. The emission rate of measureable hypernuclei from Σ^- capture is found to be $(3.7 \pm 0.9)\%$. For hypernuclei of charge $Z \geqq 2$ the overall non-mesic to mesic decay ratio is 4.2 ± 1.9. (auth)

25500 POLARIZATION AND NUCLEAR PHOTOEFFECT. J. Sawicki (Istituto Nazionale di Fisica Nucleare, Rome and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (1), 2: Suppl., 196-205(1964). (In German)

The nuclear photoeffect in the case of polarization is considered theoretically for the photofission of deuterons, based on the experimental data reported in the literature. The case of ^{9}Be and ^{13}C is also considered. (J.S.R.)

25501 ON THE QUASI-PARTICLE METHOD IN NUCLEAR SPECTROSCOPY. E. Salusti (Istituto Nazionale di Fisica Nucleare, Rome and Laboratoire Joliot Curie de Physique Nucleaire, Orsay, France). Nuovo Cimento (10), 37: 199-207(May 1, 1965).

The low-energy states of the spherical even-odd nuclei were examined: a possible wave function is proposed and discussed. In particular it is compared with the one quasi-particle states. (auth)

25502 INELASTIC ELECTRON SCATTERING. M. Gourdin (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 37: 208-16(May 1, 1965).

The general structure of the differential cross section of inelastic electron scattering is given in the first electromagnetic Born approximation for an arbitrary number of final particles. Particular attention is given to the limiting cases of a real photon and of elastic scattering. The relation between electrodisintegration and photodisintegration is considered. (C.E.S.)

25503 (M1-M2) MIXING-RATIOS IN $2' \rightarrow 2$ TRANSITIONS IN EVEN-EVEN NUCLEI AS A TEST OF PURITY OF THE VIBRATIONAL STATES. A. S. Venkatesha Murthy, S. M. Brahmavar, and M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Nuovo Cimento (10), 37: 333-4(May 1, 1965).

An error in the calculation of the theoretical value of the mixing ratio in $2' \rightarrow 2$ transition in even-even nuclei in a previous work (Nuovo Cimento, 29: 549(1963)) is discussed, and revised data are presented. (C.E.S.)

25504 THE INDUCED PSEUDOSCALAR AND TENSOR COUPLINGS IN THE PROCESS $\mu^- + {}^3He \rightarrow {}^3H + \nu$. A. Bietti (California Inst. of Tech., Pasadena). Nuovo Cimento (10), 37: 337-41(May 1, 1965).

The induced pseudoscalar and tensor coupling constants in the process $\mu^- + {}^3He \rightarrow {}^3H + \nu$ are calculated and compared with the Goldberger-Treiman relations. The calculations take into account the Gaussian and Irving wave functions. (C.E.S.)

25505 THE ^{6}Li(^{3}He,n)^{8}B REACTION AND THE EXCITED STATES OF ^{8}B. U. Fasoli, D. Toniolo, and G. Zago (Universita, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 37: 349-53(May 1, 1965).

The energy level configuration of ^{8}B was studied by determining the neutron spectra from the ^{6}Li(^{3}He,n) reaction by the time-of-flight technique. Time-of-flight spectra were taken for ^{3}He incident energies between 4.5 and 5.3 Mev at angles between 0 and 90° with flight paths of 2 and 3 m. Evidence for the existence of a level of ^{8}B with an excitation energy of (0.767 ± 0.012) Mev was obtained. (C.E.S.)

25506 ABSORPTION OF PHOTONS WITH $E_\gamma^{max} =$ 1 Gev IN ^{4}He. P. E. Argan (Universita, Naples and Istituto Nazionale di Fisica Nucleare, Naples), G. Mantovani, and A. Piazzoli. Nuovo Cimento (10), 37: 376-81(May 16, 1965).

Experimental results on the high-energy photoeffect in ^{4}He with $E_\gamma^{max} = 1$ Bev are presented. In the energy range

(0 to 170) Mev the data are in good agreement with other measurements. In the range (170 to 1000) Mev the data indicate that the γ-ray absorption in ^{4}He occurs mainly through π photoproduction. (auth)

25507 EFFECT OF COHERENCE OF ROTATIONAL MOTIONS ON NUCLEAR MAGNETIC RELAXATION. R. De Micheli and L. Giulotto (Universita, Padua). Nuovo Cimento (10), 37: 726-38(May 16, 1965).

The nuclear magnetic relaxation due to reorientational motions of molecules with two antiparallel equilibrium positions is reconsidered. The associated correlation function is generalized in order to make it independent from the initial state of the system. A simple expression, which differs from the B.P.P. one in a factor due to the presence of a certain amount of coherence in the motion, is found for $(T_1)_{intra}$ in the case of narrowing motion. The conditions under which an effect of coherence can influence the value of $(T_1)_{intra}$ are discussed. (auth)

25508 INTERFERENCE EFFECTS BETWEEN NUCLEAR AND COULOMB INTERACTIONS OF POSITIVE AND NEGATIVE PIONS IN NUCLEAR EMULSION. G. W. van Apeldoorn, M. De Boer, D. J. Holthuizen, and J. C. Kluyver (Universiteit, Amsterdam). Nuovo Cimento (10), 37: 771-3(May 16, 1965).

In order to investigate the validity of a model previously used to calculate the interference between the real part of the nuclear scattering amplitude and the Coulomb scattering amplitude, the elastic scattering of positive and negative pions in a nuclear emulsion was investigated at 4 Bev/c. The positive interference in the angular distribution of the positive pions was compared directly with the negative interference in the angular distribution of the negative pions, as the pure nuclear scattering of positive and negative pions from nuclei with almost equal numbers of protons and neutrons may safely be assumed to be the same. (C.E.S.)

25509 THE ABSORPTION OF π-MESON BY ^{6}Li. Y. Sakamoto (Kyoto Univ.). Nuovo Cimento (10), 37: 774-8 (May 16, 1965).

The energy spectrum of the recoil alpha particle following the absorption of stopped mesons(π^-) by the ^{6}Li nucleus is calculated. It is shown that the energy spectrum of the recoiling alpha particle gives information about the relative momentum distribution between the centers of mass of the s-nucleons and of the p-nucleons. (C.E.S.)

25510 CALCULATIONS OF NUCLEAR SPECTRA OF MERCURY USING INTERMEDIATE COUPLING. N. Bijedic (Institut "Boris Kidric," Belgrad and Institut "Ruder Boskovic," Zagreb). Phys. Letters, 16: 47-9(May 1, 1965).

A model in which two holes, distributed over the single particle states $s_{\frac{1}{2}}$, $d_{\frac{5}{2}}$, $h_{\frac{11}{2}}$, and $d_{\frac{3}{2}}$, are coupled to a quadratic harmonic vibrator was used to calculate the nuclear spectra of even-A Hg isotopes. Calculations were also performed for different values of single hole states, vibrator frequency, and coupling strengths, and the results are reported. Comparison is made with experiments on ^{198}Hg. (L.B.S.)

25511 ISOBARIC SPIN PURITY IN ISOBARIC ANALOGUE STATES. G. S. Mani and G. C. Dutt (Univ. of Manchester, Eng.). Phys. Letters, 16: 50-1(May 1, 1965).

The ^{89}Y(p,n)^{89}Zr reaction was studied using the time-of-flight method with a pulsed beam of 12 ns width. The neutrons leaving the ^{89}Zr nucleus in its ground state and its first excited state were observed and angular distributions were taken over the region of the isobaric resonances having spins 2^- and 3^-. The reduced width for protons and neutrons for the two resonances were evaluated and the results are tabulated. Conclusions are made on the amount and nature of the mixing of the analog states with the background states. (L.B.S.)

25512 COULOMB EXCITATION AND THE SCATTERING OF 43-Mev ALPHA PARTICLES BY Pb^{208}. G. R. Satchler (Oak Ridge National Lab., Tenn.), H. W. Broek, and J. L. Yntema. Phys. Letters, 16: 52-3(May 1, 1965).

The effects of Coulomb excitation on the inelastic scattering of 43-Mev alpha particles from enriched ^{208}Pb targets of 18 mg/cm^2 thickness were studied. The alpha particles were detected with surface-barrier and Li-drifted silicon detectors. The optical model analysis of the elastic scattering was made with the Woods-Saxon potential plus the Coulomb potential from a uniformly charged sphere. The inelastic scattering was calculated by means of the distorted-wave formalism and the collective model. Angular distributions for the excitation of the 3^- level at 2.65 Mev, the groups found at excitation energies of the 3.22 ± 0.04, 4.29 ± 0.06, and 5.61 ± 0.07 Mev are shown and compared with theoretical results. (L.B.S.)

25513 STUDY OF TWO-HOLE STATES IN LIGHT NUCLEI BY MEANS OF $(\pi^+,2p)$ REACTIONS. G. Charpak (CERN, Geneva), G. Gregoire, L. Massonnet, J. Saudinos, J. Favier, M. Gusakow, and M. Jean. Phys. Letters, 16: 54-6(May 1, 1965).

Targets of ^{6}Li, ^{7}Li, CD_2, CH_2, and liquid nitrogen were bombarded with a beam of 106-Mev pions from the CERN synchrocyclotron, and the summed energy spectra of the two protons were measured for the $(\pi^+,2p)$ reaction on ^{6}Li, ^{7}Li, ^{12}C, and ^{14}N. The structure expected from the two-hole interpretation of the final nuclear states was clearly displayed for the ^{6}Li$(\pi^+,2p)^4$He reaction; the absence of the structure in the spectra of the other reactions is attributed to poor energy resolution and the natural widths of the hole states. (L.B.S.)

25514 ANALOGUE STATES FROM THE (He^3,d) REACTION ON Fe^{54}, $Ni^{58,60}$. A. G. Blair and D. D. Armstrong (Los Alamos Scientific Lab., N. Mex.). Phys. Letters, 16: 57-9(May 1, 1965). (LA-DC-7024)

The results of an experimental study of the (^{3}He,d) reaction on ^{54}Fe, ^{58}Ni, and ^{60}Ni, in which isobaric analog states are excited, are reported. Angular distributions of the strongly excited analog states of ^{55}Co, ^{59}Cu, and ^{61}Cu are presented and compared with predictions from distorted wave calculations. The strength of each analog state obtained from analysis of data on the (d,p) reaction and shell model analysis are also compared. The results indicate a preference for the method of analysis using the wave function for a nucleon moving in a potential well adjusted to give a binding energy equal to the nucleon separation energy. (L.B.S.)

25515 EXPERIMENTAL AND THEORETICAL PARTICLE PARAMETERS FOR L ELECTRONS. DIRECTIONAL CORRELATIONS IN Hg^{199}. J. E. Thun, H. Snellman, S. Toernkvist, F. Falk, E. Aisenberg, and H. Vigneau (Inst. of Physics, Uppsala). Phys. Letters, 16: 60-2(May 1, 1965).

The 50-kev ($L_I + L_{II}$) – 158-kev γ correlation in ^{199}Hg was measured, using a magnetic lens spectrometer and a NaI(Tl) gamma detector. Measurements were made using three different L_I to L_{II} intensity ratios in the electron channel and the results are presented. The results are analyzed using previously calculated particle parameters for L_I and L_{II} electrons. (L.B.S.)

25516 CONFIGURATION MIXING IN THE CONTINUUM AND NUCLEAR REACTIONS. [PART] I. C. Bloch and V. Gillet (Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France). Phys. Letters, 16: 62-4(May 1, 1965).

A method is proposed for the treatment of unbound configurations, which is an extension of the diagonalization method used for discrete configurations. The nuclear hamiltonian is split into an independent particle part H_0 and a residual interaction V. The problem of determining nuclear reaction amplitudes is essentially reduced to the diagonalization of the hamiltonian, using the Slater determinants as a basis, which are eigenfunctions of H_0. The method is tested by applying it to the scattering of an s-wave by a square well potential. (L.B.S.)

25517 ANALYSIS OF $Ni^{62}(He^3,d)Cu^{63}$ IN THE QUASI-BOSON PLUS QUASI-PROTON SCHEME. W. Beres (Univ. of Maryland, College Park). Phys. Letters, 16: 65-8 (May 1, 1965).

The quasi-boson plus quasi-proton scheme is used for

the determination of single particle aspects of the predicted levels of ^{63}Cu from the ^{62}Ni(^{3}He,d)^{63}Cu reaction. Diagonalizations of the energy matrices were carried out for ^{63}Cu to obtain the odd parity levels for the various values of the total angular momentum. General expressions for the spectroscopic factors and sum rules are derived and calculations are made, which incorporates particle capture by both the ground and first 2^+ excited state of the target. B(E2) values and normalized experimental spectroscopic factors are also presented. The ^{63}Cu eigenfunctions of negative parity states in the scheme are tabulated. The possibility for levels having both collective and single particle aspects is observed from the spectroscopic factors. (L.B.S.)

25518 ELASTIC SCATTERING OF TRITONS FROM C^{12}, O^{16}, AND Mg^{24}. R. N. Glover (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.) and A. D. W. Jones. Phys. Letters, 16: 69-70(May 1, 1965).

Angular distributions were measured for triton elastic scattering on ^{12}C and ^{16}O at 12 Mev and on ^{24}Mg at 10 Mev from 20 to 170°. Excitation energies were measured at 150, 160, and 170° from 9 to 13 Mev in intervals of 1 Mev. An optical model analysis was made of the angular distributions, and the theoretical fits to the experimental data are shown. The parameters obtained from the analysis are tabulated. (L.B.S.)

25519 DIRECT MEASUREMENT OF THE MAGNETIC MOMENT OF PLUTONIUM-239. J. Faust, R. Marrus, and W. A. Nierenberg (Univ. of California, Berkeley). Phys. Letters, 16: 71-2(May 1, 1965). (UCRL-16005)

The result of a direct measurement of the magnetic moment of ^{239}Pu by the method of triple resonance in an atomic beam is reported. The hyperfine constants determining the frequencies corresponding to the center of the resonance line of the normal flop-in transition were taken from the data of Hubbs et al. The data were analyzed by combining the observed resonances of Hubbs et al. with the triple-resonance data and making a least-squares fit to the hamiltonian using an IBM 7090. The value obtained was $\mu_I(239) = +0.200(4)$ nm. Previous measurements are also presented for comparison. (L.B.S.)

25520 PERTURBED DIRECTIONAL CORRELATION IN TANTALUM-181. R. W. Sommerfeldt, T. W. Cannon, L. W. Coleman, and L. Schecter (Oregon State Univ., Corvallis). Phys. Rev., 138: B763-5(May 24, 1965).

The effect of a static quadrupole interaction on the 133-482-kev gamma-gamma angular correlation in ^{181}Ta was studied by the delayed-coincidence method. Using a source of ^{181}Hf in polycrystalline hafnium metal, the anisotropy was measured as a function of the time between the formation and decay of the 482-kev state with a fast-slow coincidence spectrometer. The anisotropy as a function of time clearly revealed fluctuations arising from the reorientation of the nuclear spin due to coupling of the quadrupole moment of the 482-kev state with the electric-field gradients of the crystals. The interaction strength evaluated on the basis of the theory for axially symmetric gradients was $\omega_0 = 299 \pm 8$ Mc. Evidence for the presence of a rhombic (non-axially-symmetric) electric interaction was observed in the departure of the results from the predictions for the axially symmetric case. The results are, however, in agreement with the theory for rhombic interactions if the electric field gradient in the hafnium crystals is assumed to have an asymmetry parameter $\eta = 0.30 \pm 0.03$, and in addition, if a normal frequency distribution of full width at half maximum equal to 10% is used to describe the variation of the field gradient from site to site. Further, using the evidence from Coulomb excitation for the strong deformation of the tantalum nucleus, the quadrupole moment of the 482-kev state was determined to be $Q = (2.53 \pm 0.10) \times 10^{-24}$ cm^2. This allows the calculation of the field-gradient magnitudes in metallic hafnium, which yields $V_{zz} = \pm (5.18 \pm 0.27) \times 10^{17}$ v/cm^2, $V_{yy} = \mp (3.37 \pm 0.19) \times 10^{17}$ v/cm^2, and $V_{xx} = \mp (1.81 \pm 0.25) \times 10^{17}$ v/cm^2. Incidentally, the half life of the 482-kev state was remeasured to be 10.4 ± 0.2 nsec, consistent with prior determinations. (auth)

25521 ELECTRONIC ANGULAR MOMENT OF SOME LOW-LYING STATES OF CERIUM; NUCLEAR SPIN OF CERIUM-143. Isaac Maleh (Univ. of California, Berkeley). Phys. Rev., 138: B766-9(May 24, 1965). (UCRL-11794)

The electronic angular momenta of some low-lying states of cerium were determined by means of the atomic-beam magnetic resonance technique. The work was done on the 32-day ^{141}Ce isotope using both the reported nuclear spin result of ^{141}Ce ($I = \frac{7}{2}$) and the g_J states as determined on ^{140}Ce. The results are: $g_J = -1.0772$, $J = 3$; $g_J = -0.9454$, $J = 4$; $g_J = -0.7651$, $J = 4$. Configuration mixing is required to interpret these results. By the same experimental method the nuclear spin of ^{143}Ce was determined. The result ($I = \frac{1}{2}$) is consistent with angular correlation data and decay schemes of this isotope. (auth)

25522 RADIOACTIVE DECAY OF Sn^{111}. John W. Snyder and M. L. Pool (Ohio State Univ., Columbus). Phys. Rev., 138: B770-3(May 24, 1965).

Sources of 35-min ^{111}Sn were made by the reactions ^{112}Sn(γ,n)^{111}Sn, ^{112}Sn(n,2n)^{111}Sn, and ^{110}Cd(^{3}He,2n)^{111}Sn. The ratio ec/β^+ was determined to be 2.7 ± 0.2. The following gamma rays were observed by scintillation techniques: 750, 970, 1140, 1540, 1590, 1890, 2110, and 2320 kev. The following levels in ^{111}In are proposed, based on coincidence studies and transition probabilities: 970, 1140, 1540, 1890, 2110, and 2320 kev. (auth)

25523 SPIN, HYPERFINE STRUCTURE, AND NUCLEAR MAGNETIC DIPOLE MOMENT OF 7.7-Min K^{38}. E. A. Phillips, O. Ames, and S. S. Glickstein (Princeton Univ., N. J.). Phys. Rev., 138: B773-7(May 24, 1965). (PUC-1964-155)

The spin and hyperfine structure of 7.7-min ^{38}K were determined by the atomic-beam magnetic-resonance method. About 100 mg of ^{39}K was placed in an oven in the resonance apparatus and was bombarded with an 0.3 μA beam of 18-Mev protons. The ^{38}K was produced by the reaction ^{39}K (p,d or pn)^{38}K, and the resulting specific activity was high enough so that an adequate atomic beam could be maintained 2 to 3 h before the oven was empty. Both $\Delta F = 0$ and $\Delta F = 1$ resonances were observed, and final values are $I = 3$, $\Delta\nu = 1415.292 \pm 0.009$ Mc. Comparison with other potassium isotopes yields $\mu_I = +1.3735 \pm 0.0010$ nm (diamagnetically corrected). The value for the magnetic dipole moment is in good agreement with the prediction based on the coupling of a $d_{\frac{3}{2}}$ neutron hole and a $d_{\frac{3}{2}}$ proton hole to the above spin value. (auth)

25524 BETA-GAMMA ANGULAR-CORRELATION MEASUREMENTS ON Rb^{86} AND Rb^{84}. P. C. Simms, A. Namenson, T. H. Wei, and C. S. Wu (Columbia Univ., New York). Phys. Rev., 138: B777-83(May 24, 1965).

The energy dependence of the beta-gamma directional correlation of ^{84}Rb and ^{86}Rb were measured. The results are $\alpha = 0.084 \pm 0.015$ and $\beta = 0.020 \pm 0.012$ for ^{86}Rb and $\alpha = 0.038 \pm 0.012$ and $\beta = -0.009 \pm 0.009$ for ^{84}Rb when the directional-correlation function is written in the form $N(W, \theta) = 1 + (p^2/W)(\alpha + W\beta)P_2(\theta)$. The angular dependence of the circular polarization of ^{86}Rb was also measured. The results show that there is a large $P_3(\theta)$ contribution to the circular-polarization correlation. (auth)

25525 NUCLEAR-MATRIX ELEMENTS IN FIRST-FORBIDDEN BETA DECAY—Rb^{86} AND Rb^{84}. P. C. Simms (Columbia Univ., New York). Phys. Rev., 138: B784-5 (May 24, 1965).

Theoretical formulas that include finite-nuclear-size corrections and higher-order matrix elements are given for the analysis of first-forbidden beta transitions. The formulas are arranged so that the contribution of the higher-order matrix elements can be seen clearly. Examples are given that illustrate when the higher-order terms must be included and when they can be neglected. The procedure for determining nuclear-matrix elements with a computer is discussed. Particular attention is given to the problem of setting limits of error. Nuclear-matrix elements for ^{86}Rb and ^{84}Rb are discussed. The results show that the B_{ij} matrix element dominates in both transitions. The agreement with the predictions of

conserved-vector-current theory is good. Further experiments are suggested which would set better limits on the nuclear-matrix elements. (auth)

25526 LOW-LYING EXCITED STATES OF Sc^{46} POPULATED IN THE THERMAL-NEUTRON CAPTURE REACTION $Sc^{45}(n,\gamma)Sc^{46}$. H. H. Bolotin (Argonne National Lab., Ill.). Phys. Rev., 138: B795-803(May 24, 1965).

The thermal-neutron capture reaction $^{45}Sc(n,\gamma)^{46}Sc$ was utilized to populate low-lying states in ^{46}Sc by means of γ-ray cascades from the compound-nucleus capture level. Scintillation singles and coincidence γ-ray spectroscopy techniques were used to study the gamma-ray decay characteristics of the levels observed. A rather complete set of data was obtained for transitions between levels at excitation energies up to 0.675 Mev. Levels at 0.142, 0.225, 0.289, 0.445, 0.585, and 0.675 Mev were inferred, and the decay characteristics of each of these states were determined. In addition, many levels up to an excitation energy of 3.62 Mev were observed and the principal γ-ray decay modes of these states are described. Conventional and time-to-pulse-height delayed-coincidence techniques were employed to establish the prompt ($t_{\frac{1}{2}} \lesssim 2 \times 10^{-9}$ sec) lifetimes of the 0.225-, 0.289-, 0.445-, 0.585-, and 0.675-Mev states. The isomeric character ($t_{\frac{1}{2}}$ = 20 sec) of the state at 0.142 Mev was confirmed. A complete decay scheme for states up to an excitation energy of 0.675 Mev is proposed, and the observed characteristics of these levels are compared with previous (d,p) stripping studies and recent theoretical calculations. In addition, a decay scheme is also presented which involves states at higher excitation energies (≤3.62 Mev) and includes the γ-ray decay modes observed. (auth)

25527 THREE-BODY CORRELATIONS IN NUCLEAR MATTER. H. A. Bethe (Cornell Univ., New York and Nordisk Institut for Teoretisk Atomfysik, Copenhagen). Phys. Rev., 138: B804-22(May 24, 1965).

The energy of nuclear matter which is due to the simultaneous interaction of three nucleons is calculated to all orders of Goldstone perturbation theory. The various orders form a divergent series with alternating signs. This series is summed by an integral equation due to Faddeev, and an approximate solution of this equation is found. According to this solution, the effect of the repulsive core on the potential energy of particle states is reduced to about one-third as compared with the usual third-order calculation, while the long-range attraction is essentially unchanged. The total potential energy of the important excited particle states is thereby reduced essentially to zero. Similarly, the total effect of three-body correlations on the energy of nuclear matter is very small, of the order of 3 to 6% of that of the two-body correlations. Thus the Goldstone series, if rearranged into a series in the number of interacting particles (which also corresponds roughly to powers of the density), converges very rapidly. The energy of nuclear matter is reduced substantially by the theory. When the theory is combined with Wong's idea of a "soft" repulsive core, the binding energy becomes roughly 13 Mev per particle, in much better agreement with observation than other recent estimates. (auth)

25528 PROPERTIES OF FINITE NUCLEI. H. S. Koehler (Univ. of California, San Diego, La Jolla). Phys. Rev., 138: B831-46(May 24, 1965).

The application of the reaction-matrix theory to the calculation of binding energies and other properties of finite nuclei is investigated. The nuclei ^{16}O and ^{40}Ca are considered. The single-particle wave functions are obtained from a self-consistent shell-model potential defined so as to minimize the total energy of the nucleus. The attractive part of the reaction matrix is derived from the long-range part of a central spin-independent potential acting in S states only. The nonlocality of this reaction matrix in the effective-mass approximation is treated, and the nonlocal shell-model potential is then also obtained in the similar form. For the repulsive part of the reaction matrix the local-density approximation of Brueckner and co-workers is compared with a more detailed one. It is found that the local-density approximation gives an underestimate of the binding by 2-2.5 Mev/nucleon. The center-of-mass correction increases the calculated binding further with 0.8 and 0.2 Mev/nucleon in ^{16}O and ^{40}Ca, respectively. The possibility of replacing the nonlocal shell-model potential by certain local potentials is investigated. Use is made of the harmonic oscillator and the Gaussian potentials, minimizing the energy with respect to the one parameter for the first, and the two parameters for the second. The binding differs by not more than 0.2 Mev/nucleon between these local potentials and the nonlocal self-consistent potential. In fact the local potentials often give more binding, owing to approximations necessary in the self-consistent potential in some cases. (auth)

25529 DOUBLE-CHARGE-EXCHANGE SCATTERING OF PIONS FROM NUCLEI. R. G. Parsons (Stanford Univ., Calif.), J. S. Trefil, and S. D. Drell. Phys. Rev., 138: B847-50(May 24, 1965). (SLAC-PUB-63)

Pions offer a unique possibility as probes of nuclear structure since they can exchange two units of electrical charge unaccompanied by other quantum numbers. The double-charge-exchange cross section for the reaction $\pi^- + {}^3He \rightarrow \pi^+ + 3n$ was calculated in the impulse approximation using the Chew-Low model for the pion-nucleon interaction. Only the dominant 3-3 channel is retained. For incident pions in the energy region of several hundred Mev, values of the differential cross section of $d^2\sigma/d\Omega dE \approx 1\text{-}10\ \mu b/$ Mev are obtained for forward angles. Triple-scattering terms are also calculated and found to introduce corrections of $< 10\%$ in $d^2\sigma/d\Omega dE$. Similar results are obtained when the work is extended to the reaction $\pi^+ + {}^{18}O \rightarrow \pi^- + {}^{18}Ne$ using shell-model wave functions. (auth)

25530 LEVELS OF Tl^{206} AS OBSERVED AT HIGH RESOLUTION WITH THE $Tl^{205}(d,p)Tl^{206}$ REACTION. John R. Erskine (Argonne National Lab., Ill.). Phys. Rev., 138: B851-6(May 24, 1965).

The energy level structure of ^{206}Tl was investigated with the $^{205}Tl(d,p)^{206}Tl$ reaction induced with a 12-Mev beam from a tandem Van de Graaff. The proton spectrum was studied with a broad-range magnetic spectrograph at scattering angles from 20 to 90°. A ground-state Q value of 4.276 ± 0.005 Mev was measured for this reaction. Forty-four levels were observed. Below 1.5-Mev excitation energy, levels were found at 263, 305, 635, 650, 802, 998, 1117, and 1335 kev excitation. On the basis of the differential-cross-section and angular-distribution measurements, the ground state and 305-kev state appear to belong to the $s^1_{\frac{1}{2}}p^1_{\frac{1}{2}}$ configuration with spins of J = 0 and 1, respectively. The 263- and 650-kev states probably are the J = 2 and 3 members, respectively, of the $s^1_{\frac{1}{2}}f^5_{\frac{1}{2}}$ configuration. The 635- and 802-kev states probably are the J = 2 and 1 members, respectively, of the $s^1_{\frac{1}{2}}p^3_{\frac{1}{2}}$ configuration. Data on the $^{207}Pb(d,p)^{208}Pb$ reaction were taken to aid in the interpretation of the data. (auth)

25531 ALPHA-PARTICLE ANGULAR DISTRIBUTIONS AND SPECTRA FROM DEUTERON BOMBARDMENT OF NITROGEN. W. A. Schier and C. P. Browne (Univ. of Notre Dame, Ind.). Phys. Rev., 138: B857-65(May 24, 1965).

Angular distributions from $^{14}N(d,\alpha)^{12}C$ to the ground state and the 4.44-, 7.66-, 9.65-, 10.85-, 11.84-, and 12.71-Mev states of ^{12}C were measured at a deuteron energy of 4 Mev, and those of the 12.71-, 13.29-, 14.08- and 15.11-Mev states were obtained at 7.2 Mev. The nearly symmetric individual and summed distributions suggest that the statistical model of the compound nucleus applies to this reaction. An additional two-nucleon pickup contribution accounts for small frontal peaking at 7.2 Mev. The 10.1-Mev ^{12}C level was not observed. A width of 355 ± 50 kev was measured for the 13.29-Mev state. (auth)

25532 DAMPING OF THE GIANT RESONANCE IN HEAVY NUCLEI. Michael Danos (National Bureau of Standards, Washington, D. C.) and Walter Greiner (Univ. of Maryland, College Park). Phys. Rev., 138: B-876-91 (May 24, 1965).

In heavy nuclei the damping of the giant resonance is due to thermalization of the energy rather than to direct emission of particles; the latter process is strongly inhibited by the angular-momentum barrier. The thermalization proceeds via inelastic collisions leading from the particle-hole state to two-particle–two-hole states. In heavy nuclei, several hundred such states are available at the energy of the giant dipole resonance. The rather large width of the giant resonance arises from the addition of many small partial widths of channels leading to the different two-particle–two-hole states. Both the density of the two-particle–two-hole states and the mean value of the interaction matrix elements between the particle-hole and two-particle–two-hole states are evaluated in a simplified square-well shell model. In a given nucleus the energy dependence of the widths is determined mainly by the density of states; the A dependence is determined mainly by the size of the matrix elements. For $A \approx 200$, it was found that $0.5 \text{ Mev} \leq \Gamma \leq 2.5 \text{ Mev}$. The uncertainty in this value comes mostly from the uncertainty in the strength of the interaction. Representing the energy dependence of the width by a power law it was found for the exponent the value ~1.8. (auth)

25533 THE INFLUENCE ON THE MÖSSBAUER SPECTRUM OF APPARATUS FLUCTUATIONS IN VELOCITY AND SOURCE-ABSORBER GEOMETRY. C. Nistor. Rev. Roumaine Phys., 9: 793-808(1964). (In Russian)

The influence of the velocity fluctuations, due to the apparatus and the source-absorber geometry, on the experimental Mössbauer spectrum is studied in the case of a single γ resonance absorption line. The exact and approximate formulas are given with which the attenuation of the $\epsilon_e(V_{Oe})$ effect, the displacement of the velocity V_O corresponding to the maximum effect, and the augmentation of the half width G_e of the Mössbauer spectrum in some usual cases are calculated. Some general properties of the variation of these parameters are analyzed. (tr-auth)

25534 THE ION CHARGE OF FISSION PRODUCTS IN DEPENDENCE ON THEIR ENERGIES. H. Opower, E. Konecny, and G. Siegert (Technische Hochschule, Munich and Universitat, Gissen, Ger.). Z. Naturforsch., 20a: 131-40(Jan. 1965). (In German)

Fission products from a U layer brought near the FRM reactor were deflected in the electric field of a toroid condensor and analyzed with a barrier layer counter. The total beam path is in a vacuum. From the measurement results, the distribution of the ion charge numbers of the fission products follows as a function of their energy. The half-value width of these distributions in the region of the heavy mass groups is about 7 charge units and in the region of the light, about 4.5. The mean charge value increases in each group with the energy, and in the transition from the heavy to the light group a jump to lower values of about 3.7 units occurs. For extension of the measurement range to lower energies, the fission products were slowed down with formvar foils of various thickness to a maximum of a fourth of their initial energy. The mean charge numbers, separated for the light and heavy mass groups, were given as a function of the velocity of the particles. With respect to the rule formulated by Bohr, that on an average all electrons are stripped from the fission product ions and that their orbit velocities are smaller than the ion flight velocities, the charge numbers found were compared with those derived theoretically using the Thomas-Fermi model as a function of the orbit velocities of the slowest electrons remaining bound. It was shown that the difference of the orbit velocities of these electrons and the flight velocities of the fission-product ions in the total measured range has the almost constant value 0.28 (in units $Z^{-\frac{1}{3}} \cdot e_o^{2/\hbar}$). (tr-auth)

25535 PRODUCTION OF Be^7 FROM O^{16} WITH BREMSSTRAHLUNG UP TO 57 Mev. H. Artus (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 20a: 320 (Feb. 1965). (In German)

The production of ^{7}Be was investigated using targets of bidistilled water and graphite and measuring the ^{7}Be activity relative to that of ^{11}C from the $^{12}C(\gamma,n)^{11}C$ reaction. The production cross section was found to have a maximum at about 46 Mev and to be 0.012 mb at 57 Mev. (D.C.W.)

25536 DEUTERON PLUS HELIUM REACTION AND SCATTERING CROSS SECTIONS. Robert Emil Rothe. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 78p.

A differentially pumped gas scattering chamber with a solid state detector was used to obtain differential cross sections for the $^4He(d,d)^4He$ interaction and proton differential cross sections per Mev from the deuteron break-up process. The latter data were integrated over various portions of the energy interval occupied by the proton group; the energy intervals extended from the maximum possible proton energy downward to 40%, 50%, and 60% of that energy. An excitation curve was taken at $\theta_{LAB} = 14°$ in the energy region $E_d = 5.7 - 14.3$ Mev. The energy steps were ~ 5 kev in the neighborhood of reported T = 1 levels in Li^6(5.88, 7.75, and 10.34 Mev) and were 50 kev elsewhere. The target thickness was < 1 kev. The deuteron break-up process for $\theta_{LAB} = 14°$ was adequately explained in terms of the sequential two-body reactions $^4He(d,p)^5He(n)^4He$. An angular distribution of the proton cross section qualitatively exhibited the forward angle peaking characteristic of stripping reactions. The proton energy spectrum agreed well (except for energies near threshold) with the calculated spectrum determined from the total p-wave cross section for the $^4He(n,n)^4He$ interaction. No resonant structure was seen in the proton or deuteron cross sections; in particular the T = 1 regions were free of any structure exceeding the ± 2% experimental uncertainty. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25537 ALPHA PARTICLE RESONANCE. Paul P. Szydlik. Thesis, Washington, D. C., Catholic Univ. of America, 1964. 51p.

The resonating group approximation was used to treat theoretically S-wave scattering for the t-p and $n-^3He$ elastic channels as well as for the reactions $T(p,n)^3He$ and $^3He(n,p)T$. The Schrödinger wave equation transforms into the form of an integro-differential equation, which represents the interaction of the fourth nucleon with an A = 3 core. Variational wave functions of Gaussian form, which give the proper rms charge radius of the triton, are used to represent the core, while the wave function of the fourth particle is determined from the numerical solution of the integrodifferential wave equation using only central even-parity potentials of Gaussian form. The boundary conditions that join these latter functions to the appropriate free-particle solutions outside the range of the nuclear potential are then used to evaluate the 2×2 collision matrix from which the cross sections are determined. The resonance condition that the total S-wave phase shift pass through 90° is not satisfied. However, there is a large cusp in the t-p elastic cross section at the $n-^3He$ threshold, which may be interpreted in terms of a quasi-bound state of the $n-^3He$ system at 670 kev in the t-p center-of-mass system or at 20.48 Mev excitation in the alpha particle. Further justification for this interpretation is given by the fact that the calculated $^3He(n,p)T$ cross section falls off faster than the expected 1/v behavior. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25538 NUCLEI AND PARTICLES. An Introduction to Nuclear and Subnuclear Physics. Emilio Segre. New York, W. A. Benjamin, Inc., 1964. 754p. $15.00.

Theory for nuclear decay, reactions, and structure is presented, together with the associated experimental observations. Neutron physics, subnuclear particles, and interactions of radiations with matter are also treated. Particle accelerators and instruments for the detection and measurement of radiation are discussed. (D.C.W.)

25539 NEUTRON-GAMMA ANGULAR CORRELATIONS AT LOW DEUTERON ENERGY. Leendert van der Zwan. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 132p.

Neutron-gamma angular correlations for the reaction $^{13}C(d,n\gamma)^{14}N$ at a deuteron energy of 1 Mev were measured (1) at neutron detector positions of 20, 45, 90, and 130° with

the γ detector moving in the reaction plane and (2) at neutron detector angles of 20, 45, and 90° with the γ detector rotating in a cone 41° out of the reaction plane. For the reaction $B^{11}(d,n\gamma)C^{12}$ at a deuteron energy of 1 Mev neutron-gamma correlations were obtained at the neutron detector angles 10 and 90° with the γ detector rotating in the reaction plane and 22° out of the reaction plane. A conventional neutron time-of-flight scheme was used. The neutron detector consisted of a RCA 7046 photomuliplier with a 3-in. × 3-in. liquid scintillator of NE 213. A RCA 6810A photomultiplier coupled to a 1 1/2-in. dia × 4-in. plastic scintillator (NE 102) served as the γ detector. The overall time resolution was approximately 2×10^{-9} sec for ^{22}Na annihilation radiation. A NaI ($1\frac{1}{2}$-in. dia. × 1-in.) crystal as the γ detector was found to reduce the background in the neutron time-of-flight spectrum of the reaction ^{13}C (d,nγ) ^{14}N. The measured anisotropies for the reaction ^{13}C (d,nγ) ^{14}N are small (0–8%). However, they consisted of essentially equal amounts of two cascade γ rays, one of which is isotropic. The ^{11}B (d,nγ)^{12}C neutron-gamma correlations showed the presence of a higher order term in the backwards neutron detector position than is expected for $l = 1$ transfer reactions. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25540 QUASI-ELASTIC PROTON-DEUTERON COLLISIONS IN Li^6 AT 30 Mev. Delbert Wayne Devins. Thesis, Los Angeles, Univ. of Southern California, 1964. 82p.

The angular correlation of proton-deuteron coincidences from the proton bombardment of an isotopically pure ^6Li target was measured to determine not only the validity of a deuteron plus alpha particle model for the ^6Li nucleus but also the applicability of medium bombarding energies for probing the nucleus. The measured angular correlation was very sharply peaked about an angle near the free proton-deuteron scattering angle, 52.2°, having a value at the peak of 8.0 ± 1.3 mb/sr^2. The angular correlation fell off very quickly on both sides of the peak, having a full width at half maximum of 6°. The data were analyzed by using the impulse approximation and a classical hard sphere interaction. A computer program was written, which evaluated the laboratory differential cross sections. The calculations using distribution function of the form $P(q,\theta) = 1/(q^2 + q_a^2)^2$ provided a very good fit to the data for $10 \leq q_a \leq 20$ Mev/c. A distribution function of the form $P(q,\theta) = \exp(-q^2/q_a^2)$ also provided good fits to the data except at large momentum transfers. This range of the parameters q_a also compares favorably to the value of 30 Mev/c obtained by the only other experiment of this nature done to date, at an incident proton energy of 155 Mev. The general shapes of the angular correlations obtained at 155 and 30 Mev were quite similar. It can be concluded (1) that the sharply peaked proton-deuteron angular correlation lends credence to the "pre-existence" of deuteron clusters in the ^6Li nucleus and (2) that at high bombarding energies as contrasted to medium incident energies, the simple single-step interaction picture cannot explain the experimental results. (A.G.W.)

25541 COUPLING SCHEMES AND EFFECTIVE INTERACTIONS IN THE NUCLEAR SHELL MODEL. Ira Myron Green. Thesis, Los Angeles, Univ. of California, 1964. 158p.

The shell model is used as a tool to study configuration mixing and the nuclear interaction. Two and four particles in the 1s-Od shell are examined and all possible configurations in the shell are included. The construction of the Hamiltonian for the proposed configuration is discussed in detail. Realistic s-state effective interactions which have some (but not all) of the features of the realistic interaction as observed in nucleon-nucleon scattering experiments, are used. In general, the spectrum obtained depends strongly on the configuration considered. The value of j for the single particle orbit also affects the type of spectrum observed. Besides the s-state interaction a surface delta function interaction model in which all radial wave functions are made is considered. In addition, a simple model is considered in which an arbitrary interaction is assumed in the J = 0 and J = 2 states of two nucleons in the same orbital, but no interaction is assumed in other states. Returning to the s-state interaction model, the structure of the s-state Talmi integrals in the 1s-Od shell is related to the variation of the coupling scheme from a pairing-type scheme to the SU_3 scheme of Elliott. The Talmi integrals are related to various effective interactions including a realistic "best fit" interaction. Realistic interactions are considered, which contain an attractive well and a hard core. They are chosen to give a bound state at zero energy and an effective range of 2.5 fermis. These free nucleon-nucleon interactions are transformed, using the separation method, into effective interactions that can be used in the shell model without yielding infinite matrix elements. The results compare favorably with the "best fit" interaction. The best and most consistent picture of the interaction is obtained when a realistic interaction with a somewhat smaller or less singular hard core than has been usually accepted is used. (A.G.W.)

25542 NEUTRON PHOTOPRODUCTION CROSS SECTIONS FOR LIGHT NUCLEI. Lee Napier Bolen, Jr. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 91p.

The absolute (γ,n) cross sections of natural silicon, phosphorus, sulfur, oxygen, and aluminum were measured using the bremsstrahlung from the 70-Mev synchrotron at the University of Virginia. Yield points were taken at 0.5-Mev intervals from 12 to 30 Mev in each case. The data were analyzed by the Leiss Penfold technique using two interlacing 1-Mev bin widths as well as $\frac{1}{2}$-Mev bin widths. Comparison with higher resolution experiments indicates that the actual cross sections are extremely complicated with hundreds of small levels contributing to the overall shape of the cross section. The measurements presented were made with sufficient resolution to define the major levels, and the results are amenable to comparison with theory. The two major levels found in oxygen agree well with the prediction of the dipole states by Brown and Gillet. A similar calculation was made in zero approximation for silicon and the results are presented. The level scheme found by this approximate method displayed a definite grouping of levels several Mev below the experimental giant resonance region, and the inclusion of the particle-hole interaction should produce a general shift upward in energy. Only one strong transition remained below the photoneutron threshold, and it was speculated that this could be responsible for the large photoproton resonance seen at 14.5 Mev. The excitation levels found in silicon in (γ,n) and (γ,p) experiments do not agree. The absolute integrated cross sections of the elements are given, and these failed to exhaust even half of the classical dipole sum rule leading to the conclusion that higher energy effects such as the quasi deuteron dipole strength. The energy level schemes found for the adjacent nuclei in the region from aluminum to sulfur showed no correlation. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25543 EXCHANGE MAGNETIC MOMENT IN THREE-BODY NUCLEI. Doran William Padgett. Thesis, Washington, D. C., Catholic Univ. of America, 1964. 65p.

Meson exchange effects are considered in an attempt to explain the nuclear magnetic moment anomaly of the three-body system. The exchange magnetic moments were calculated for the case of two-body one-meson exchange in the ground state of the three-body system by the methods of static Chew-Low theory. The ground state was assumed to be a pure space symmetric $^2S_{\frac{1}{2}}$ state. An adjustable hard core radius r_c was used in the form of a cutoff of the radial integrals for interparticle distance less than r_c. The absolute value of the total exchange moment was found to be ~0.3 nm in the hard core range of $0.5\ f \geq r_c \geq 0.3f$. The two-body one meson exchange process accounts for ~0.2 nm which is $\frac{2}{3}$ of the value reported by Villars. The remaining ~0.1 nm results from the three-body two-meson exchange process. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25544 A TEXTBOOK OF NUCLEAR PHYSICS. C. M. H. Smith. A Pergamon Press Book. New York, The Macmillan Company, 1965. 837p.

The elements of atomic physics, relativity, and quantum

mechanics that form the basis for the study of nuclear physics are presented first. Nuclear properties, decay, fission, magnetism, forces, models, and reactions are then treated, with consideration of particle accelerators and radiation detection instruments. A detailed account of elementary particle physics is given, together with an account of thermonuclear reactions in stars in which a theory of element synthesis is outlined. (D.C.W.)

25545 A CALCULATION OF THE INTERNAL PAIR PRODUCTION COEFFICIENT. Hugh Patrick Kennedy. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 109p.

The complete angular correlation of internal pairs emitted from an oriented nucleus in a mixed multipole transition is calculated in the plane wave Born approximation. It has been shown elsewhere that the Coulomb field can be accounted for by an angle independent multiplicative correction factor; so that the results presented have a wider region of applicability than criteria for validity of the plane wave Born approximation would imply. It is shown that internal pairs provide a useful tool for nuclear spectroscopy. Not only can the angular correlation be used for angular momenta and multipolarity assignments but also internal pairs can be used to make an unambiguous assignment of the multipole mixture parameter both magnitude and sign. The determination of the sign of the multipole mixture cannot be achieved using only gamma-ray data even if the polarization is measured. The procedure for the determination of the sign of the multipole mixture depends critically on the existence of an interference term between the longitudinal and transverse parts of the interaction and this is obviously absent in gamma-ray data. The spin correlation of the pair was also calculated for mixed multipole transitions in oriented nuclei using the plane wave Born approximation. However, Coulomb effects were not considered so that these results are only valid when the criteria for the validity of the plane wave Born approximation are satisfied. It is shown that the spin correlation yields information equivalent to that obtained from measuring the circular polarization of the competing gamma radiation. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25546 $C^{12}(\gamma,n)C^{11}$ OVER THE GIANT RESONANCE. Wm. A. Lochstet and Wm. E. Stephens (Univ. of Pennsylvania, Philadelphia). 7p. (CONF-758-11)

From American Physical Society Meeting, New York, Jan. 1965.

The experimental arrangement used for the irradiation of carbon targets by 19.8-Mev gamma rays from the proton capture by tritium is described, and the cross section for the $^{12}C(\gamma,n)^{11}C$ reaction was measured. Peaks were observed at 22.2, 23.05, and 25.5 Mev, and a peak at 23.7 Mev is suggested. (L.B.S.)

25547 CALCULATION OF PROTON INDUCED GAMMA RAY SPECTRUM AND COMPARISON WITH EXPERIMENT. C. W. Hill and K. M. Simpson, Jr. (Lockheed-Georgia Co., Marietta). 10p. (CONF-720-13)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Results of calculations of secondary gamma rays produced in energetic proton reactions with nuclei are reported. Processes occurring after inelastic proton-nucleus collisions — knock-on, evaporation, and emission of de-excitation gammas and of betas — are discussed. The DLIGHT code used in the calculations and the sources of error are considered. Results are presented for 150-Mev proton reactions with ^{12}C, ^{16}O, and ^{27}Al and compared with previous experimental results. Theoretical gamma-ray spectra were also calculated for bombarding energies of 25, 50, 100, 150, and 200 Mev. Gamma yields computed by the DLIGHT code for protons above 25 Mev are combined with previous data for below 25 Mev to estimate secondary gamma dose in an Al shield from a solar flare. (M.J.T.)

25548 0^+ LEVELS IN α-PARTICLE NUCLEI. Francis J. Bartis (Indiana Univ., Bloomington). 3p. (CONF-758-14).

From American Physical Society Meeting, New York, Jan. 1965.

A description of rotational motion in the superfluid state of alpha-particle nuclei was attempted, assuming that such nuclei consist entirely of spin-zero quasi-bosons or bound Cooper pairs. In the ground levels, the rotational angular momentum of each quasi-boson is zero. The excitation energies of low-lying 0^+ levels in ^{12}C, ^{40}Ca, ^{24}Mg, ^{16}O, ^{28}Si, and ^{32}S were calculated and compared with experimental values. (D.C.W.)

25549 HEAVY IONS FROM DEUTERON INDUCED REACTIONS IN O^{18} AND F^{19}. L. J. Denes and W. W. Daehnick (Univ. of Pittsburgh). 14p. (CONF-758-15).

From American Physical Society Meeting, New York, Jan. 1965.

The differential cross sections for heavy ions from reactions in ^{18}O and ^{19}F were investigated using a deuteron beam of 15 Mev. Improvements in the two-parameter data analysis (energy versus time of flight) permitted extension of previous investigations of $(d,^6Li)$ to heavier ions. Angular distributions were measured for: $^{19}F(d,^6Li)^{15}N$, $^{19}F(d,^7Li)^{14}N$, $^{19}F(d,^7Li[.478])^{14}N$, $^{19}F(d,^7Be)^{14}C$, $^{19}F(d,^7Be[.432])^{14}C$, $^{19}F(d,^9Be)^{12}C$, $^{18}O(d,^6Li)^{14}C$ and $^{18}O(d,^7Li[g.s.+.478])^{13}C$. All angular distributions are forward-peaked and resemble diffraction patterns as predicted by DWBA pickup calculations. These facts, along with the large magnitude of the cross sections suggest a direct reaction mechanism. It seems remarkable that all reactions listed have comparable forward-angle cross sections (about 100 μb/sr) even though the $(d,^7Li)$ and $(d,^7Be)$ reactions are energetically disfavored. For pickup processes such evidence indicates that the nucleon overlap for an alpha "cluster" in the ground-state wave functions of ^{18}O and ^{19}F is not favored over other, even larger correlated nucleon groups. (auth)

Plasma Physics and Thermonuclear Processes

25550 (AD-607091) RESEARCH IN THE FIELD OF PROPAGATION OF HIGH-POWER WAVES IN IONIZED MEDIA. Research (Survey) Report No. 48. O. E. H. Rydbeck (Chalmers Tekniska Hogskola, Goteborg (Sweden). Forskningslaboratorium for Elektronik). July 1, 1964. Contract AF61(052)-451. 132p. $4.00(CFSTI)

In this report a survey is given of the research in the field of propagation of high power radio waves in ionized media, and allied fields, carried out by the staff of the Research Laboratory of Electronics 1960-1964. The investigations reported cover such aspects as the development of a non-linear magneto-ionic theory, generation and radiation of mixed frequency waves in ionized media, artificial heating of the F-region of the ionosphere, scattering of electromagnetic waves by oscillating, anisotropic dielectric and ionized media, ionized stream-whistler mode interactions (in the exosphere), and wave propagation properties of moving ionized media. (CFSTI)

25551 (AFCRL-64-672) DYNAMIC NON-LINEAR WAVE PROPAGATION IN IONIZED MEDIA. 12. ELECTROMAGNETIC WAVE REFLECTION FROM AN OSCILLATING, COLLISION-FREE MAGNETO-IONIC MEDIUM. Research Report No. 43. O. E. H. Rydbeck (Chalmers Tekniska Hogskola, Goteborg (Sweden). Forskningslaboratorium for Elektronik). July 1, 1964. Contract AF61(052)-451. 60p. (AD-607090) $3.00(CFSTI)

Electromagnetic wave reflection from an oscillating, (e.g., pumped) magneto-ionic medium is treated in detail, also for the slowly inhomogeneous medium, on the basis of the non-linear magneto-ionic theory earlier developed by O. E. H. Rydbeck. The various reflection and refraction laws for the mixed frequency components, and the radiation for the same is discussed. It is also shown that one can make use of non-linear resonance effects to echo sound the ionosphere at mixed frequencies (in the 25 Mc/s range)

to obtain the true height of reflection (at the difference frequency) and the electron density gradient. Pulse powers of the order of 5 Mw would have to be used for the purpose. (auth)

25552 (AL-TDR-64-155) INVESTIGATION AND STUDY OF ELECTRON BEAM PLASMA SUBMILLIMETER GENERATION. G. A. Swartz and L. S. Napoli (RCA Labs., Radio Corp. of America, Princeton, N. J.). July 1964. Contract AF33(657)-11069. 80p. (AD-603247). CFSTI.

A stable cesium plasma with a density of 10^{15} ions/cm^3 (plasma frequency 300 Gc) and 50% ionization was produced by a modified Penning arc. The hot anode is shown to be a significant factor in the achievement of this very dense highly ionized plasma. Plasma instabilities, which are normally present in the Penning arc, were found to be rotating in the j × B direction. These instabilities were damped by collisions between the rotating ions and the stationary neutral atoms. Radial and axial plasma density variations were measured. The radial density gradient decreased when the plasma became stable. Strong coupling was measured between the TEM mode in a coaxial line and the backward wave in a tubular plasma. Analysis indicates that a tubular plasma with a large outer diameter cannot be used in a waveguide-plasma coupler because of mode coupling with the TM_{01} waveguide mode. A 300-Gc beam-plasma amplifier was designed which uses tubular plasmas as couplers and the Penning arc for plasma generation. The gain constant for eight-order modes in a beam-plasma interaction was calculated as a function of beam diameter for $1 - (\omega_p^2/\omega^2) = 0$ and -0.1. For a range of beam diameters, the gain of the lowest-order mode goes to infinity at plasma resonance while the gain of the higher-order modes remains finite. Resistive microwave loss in a plasma is considered for a calculation of the maximum efficiency of a beam-plasma amplifier. The efficiency data taken from a 23-Gc amplifier show reasonable agreement with the theory. Self-sustained r-f power in the band of 2 to 4 Gc was generated in a tubular hot-cathode arc. The r-f power was detected 45 μsec after a 0.8-μsec, 150-volt pulse was applied to the grid in front of the arc cathode. (auth)

25553 (LA-3289) SCYLLA THETA-PINCH EXPERIMENTS: STATUS, PLANS, AND PROPOSAL FOR A CLOSED TOROIDAL THETA PINCH (SCYLLAC). W. E. Quinn, F. L. Ribe, W. B. Riesenfeld, G. A. Sawyer, and J. L. Tuck (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Apr. 5, 1965. Contract W-7405-eng-36. 108p. Dep.; $4.00(CFSTI).

The Scylla IV experiment uses 3.5-MJ energy storage, and produces a plasma of density 2×10^{16} ions/cm^3, electron temperature 300 ev, and mean ion energy 3 to 8 kev. Loss of plasma from the ends of the system limits plasma confinement of the system to a few microseconds in the present experiments. A proposed theta-pinch experiment (Scyllac) in closed toroidal geometry will eliminate end losses. It is, however, necessary to add additional longitudinal windings to stabilize the plasma against the radial outward drift introduced in toroidal geometry. The theoretical stability of the toroidal plasma geometry is examined, and feasible containment systems are found. In addition, a feasibility study shows that a theta-pinch pulsed system would be practical for a power producing reactor if the basic problems of plasma physics were solved. (auth)

25554 (MATT-314) PLASMA LOSSES IN A Q-DEVICE. N. D'Angelo and S. v. Goeler (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1964. Contract AT(30-1)-1238. 27p. Dep.; $2.00(cy), 1(mn) CFSTI.

Probe and microwave measurements are presented, which support the view that the ordinary plasma of a Q-device is suitably described by the "equilibrium" model. An apparent discrepancy between results that give considerable support to the "equilibrium" model, and other results, appears to be resolved by consideration of probe losses. (auth)

25555 (RADC-TDR-64-244) A STUDY OF PLASMA APPLICATIONS IN MICROWAVE CIRCUITS. [PART] II. Final Report. A. Olte and E. K. Miller (Michigan Univ., Ann Arbor. Radiation Lab.). Aug. 1964. Contract AF30(602)-2605. 108p. (AD-606871). $4.00(CFSTI).

These studies are concerned with the potential usefulness of plasmas in microwave structures, with or without a static magnetic field. Considerable attention is given to the plasma resonance isolator and to the design and fabrication of an improved plasma package specifically intended for microwave applications. The first part of the report contains the development of a first order theory for calculating the absorption in the electron cyclotron resonance isolator, and its equivalent circuit. Two theoretical models are used to describe the plasma-electromagnetic wave interaction and are found to produce equivalent results for the range of variables investigated. The experimental work on a rectangular plasma package is described in the second part of the report. Hydrogen and xenon gases are used in hot cathode discharges to produce a plasma, and plasma frequencies of more than 10 Gc are obtained. Plasma instabilities were found to be a serious problem. (auth)

25556 (SU-ML-1291) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 20, September 1–November 30, 1964. G. S. Kino (Stanford Univ., Calif. Microwave Lab.). Jan. 1965. Contract AT(04-3)-326. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Work concerning the formation of the electron beam which issues from the cathode plasma sheath in hot-cathode discharges was completed during the period, and development of theory concerning the interaction of this beam with warm plasma was continued. Experimental work is reported on applications of electron-beam probing systems for measurements of d-c and r-f electric fields in plasma and sheath regions. A summary of previously completed work is included on low- and high-frequency phenomena. (J.R.D.)

25557 RADIATIVE FLUX FROM AN ARGON PLASMA. E. A. Brown, Jr. and P. A. Ross (Boeing Co., Seattle). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 660-5(Apr. 1965).

The radiative flux from argon to the stagnation point of a blunt body was considered. Radiative flux and total heat flux measurements were made in a shock-heated argon plasma using shock tube. The radiation intensity was calculated from the Kramers-Unsöld theory for the continuum, neglecting the line radiation. By taking the lowering of the ionization potential into account in a consistent fashion, the intensity measurements of Petschek and Olsen were shown to be in agreement. The empirical constants, the critical frequency, and effective nuclear charge squared, were estimated to be 1×10^{15} sec^{-1} and 2.7, respectively, from the structure of the argon atom and the intensity measurements. The radiative heat flux measurements agreed with the predictions within the experimental data scatter. The combined radiative and convective heat flux predictions were in agreement with the total heat flux measurements. (auth)

25558 VARIABLE COLLISION FREQUENCY EFFECTS ON HALL-CURRENT ACCELERATOR CHARACTERISTICS. H. E. Brandmaier (Curtiss-Wright Corp., Wood-Ridge, N. J.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 767-9(Apr. 1965).

The effects of the variation with collision frequency of the ratio of electron-cyclotron frequency to the mean collision frequency of electrons with ions and neutrals and of an ion-slip parameter containing the effect of the ratio of ion-cyclotron frequency to ion-neutral collision frequency during acceleration at a constant degree of ionization is analyzed. (D.C.W.)

25559 RADIANT ENERGY LOSS FROM A SEEDED PLASMA. Michael A. Lutz (Massachusetts Inst. of Tech., Cambridge). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 772(Apr. 1965).

The method and results of a calculation of the radiant energy loss from a cesium-seeded argon plasma at atmospheric pressure and 2000, 2500, and 3000°K are summarized. The results show that, for electron temperatures below 3000°K, the radiant energy loss from a seeded plasma

can be approximated by the energy loss from the two principal resonance lines. (D.C.W.)

25560 TRANSLATIONAL SYMMETRY AND ZERO-MASS EXCITATIONS. J. A. Cronin (Univ. of Chicago). Am. J. Phys., 33: 319-22(Apr. 1965). (COO-264-221; EFINS-64-55)

For a simple class of Hamiltonians of a continuous medium, it is shown that the condition of translational invariance implies a zero-energy gap in the excitation spectrum. It is also shown that because of translational symmetry a spurious state of zero energy and momentum exists for an electron plasma in a positive background. This spurious state becomes massive when translational symmetry is broken. (auth)

25561 LOCAL HEATING OF A Cs PLASMA BY MICROWAVE IRRADIATION AT THE UPPER HYBRID FREQUENCY. A. Y. Wong (Princeton Univ., N. J. and Univ. of California, Los Angeles). Appl. Phys. Letters, 6: 147-8 (Apr. 15, 1965).

The heating of a cesium plasma confined by a magnetic field by microwave irradiation at the upper hybrid frequency was observed. The temperatures were derived from measurements of wave attenuation and phase velocity. The following values were obtained: $4 < T_e/T_{e0} < 10$ and $1 < T_i/T_{i0} < 2.6$, where T_{e0} and T_{i0} are the electron and ion temperatures without irradiation. (D.C.W.)

25562 LONGITUDINAL INTERACTION OF MICROWAVES WITH AN ARGON DISCHARGE. C. A. Renton and Leon W. Zelby (Univ. of Pennsylvania, Philadelphia). Appl. Phys. Letters, 6: 167-9(Apr. 15, 1965).

The propagation of microwaves along the plasma column in a glass discharge tube with a longitudinal electric field was studied. A number of resonances was observed, which can not be explained entirely by the Tonks-Dattner mechanism. An explanation was proposed. (D.C.W.)

25563 INTERACTION OF A JET OF PLASMA WITH ELECTRIC AND MAGNETIC FIELDS. A. N. Kontaratos and S. T. Demetriades (STD Research Corp., Pasadena, Calif.). Appl. Sci. Res., Sect. B, 11: 335-60(1964-5).

A generalized ohm's law is used to predict changes in the direction and magnitude of the momentum of a stream of plasma in a crossed-field accelerator in terms of plasma properties and species temperatures and concentrations. Measurements are reported of accelerator thrust, plasma jet deflection angle, current-voltage characteristics, accelerator inlet momentum, cooling rates and cross-arc power input for argon and helium plasmas. Estimates are given of the mean values of some of the parameters of argon and helium plasma obtained under non-equilibrium conditions. These results are compared with other methods requiring the assumption of LTE. (auth)

25564 NEW SPECTRA OF THE IRON TRANSITION ELEMENTS OF ASTROPHYSICAL INTEREST. B. C. Fawcett and A. H. Gabriel (Culham Lab., Abingdon, Berks, Eng.). Astrophys. J., 141: 343-53 (Feb. 15, 1965). (CLM-P-56)

A group of intense lines between 170 and 220 Å was observed in the Zeta Discharge, and was found to coincide with intense unidentified lines previously observed in the solar spectrum. Using high-current and high-voltage sparks, these lines were reproduced and shown to be due to iron. Similar groups of lines were reproduced and measured from each of the elements from calcium to nickel. Over 300 new lines are listed in the wavelength range 400–100 Å. Two possible mechanisms for the production of these lines are considered. (auth)

25565 THE INFLUENCE OF CONDUCTING DIAPHRAGM ON THE PLASMA EQUILIBRIUM IN "TOKAMAK" INSTALLATION. V. D. Shafranov. At. Energ. (USSR), 18: 255-6(Mar. 1965). (In Russian)

The equilibrium of plasma containment by interactions between a longitudinal magnetic field and the transverse component of the current in a thin plasma cylinder shell was investigated. Such current component appears in an ideal plasma cylinder when the current circuit lines lock on a diaphragm outside the plasma forming a plasma cylinder. Formulas were developed for plasma cylinder shift binding the azimuthal field and the current on the diaphragm along the length of the shift. An approximation was developed for plasma cylinder shift contained at equilibrium in a purely toroidal magnetic field by the current on the diaphragm. (R.V.J.)

25566 ADIABATIC CONSTRICTION OF PLASMA BY HOT IONS. (INSTALLATION AND FIRST EXPERIENCES). A. V. Bortnikov, N. N. Brevnov, V. G. Zhukovskii, and M. K. Romanovskii. At. Energ. (USSR), 18: 256-7(Mar. 1965). (In Russian)

Descriptions are given of an installation for adiabatic plasma constriction by hot ions in a magnetic field rising with time. The plasma was produced by injection of 10-kev hydrogen atomic ions (or 7-kev molecular ions). The ions moving around an axis in a homogeneous field nearly perpendicular to the installation and are reflected in the magnetic mirror. The characteristics of the stationary magnetic field are given. The ion current of 1 to 5 mamps was injected by 1 to 500 msec pulses. The initial gas pressure before ion beam injection was 10^{-6} mm Hg. With the ion motion 30 μsec the density of fast ions was 10^8 cm^{-3}. The experimental data were plotted for the 1/t as a function of fast neutral atoms in the detector and for plasma potential as a function of the amplitude of the current injection component variable. (R.V.J.)

25567 DETERMINATION OF TOTAL ENERGY LOSS BY ELECTRON BEAM IN INTERACTION WITH PLASMA. A. K. Berezin, Ya. B. Fainberg, L. I. Bolotin, and G. P. Berezina. At. Energ. (USSR), 18: 271-3(Mar. 1965). (In Russian)

Descriptions are given of an installation with an open type circulating calorimeter used for measuring the total energy losses by an electron beam interacting with plasma. The mean electron beam energy at the chamber entrance (W_1) and at the exit (W_2) was measured as a function of the beam current, the plasma density and the longitudinal field intensity. The current velocity was measured with an accuracy of the order of 5%. The electron beam relative energy losses in the plasma determined from the relation $\Delta W = 1 - (W_2/W_1)$ are tabulated. (R.V.J.)

25568 ON THE PERFORMANCE OF A CYLINDER IN A STELLARATOR. B. I. Gavrilov, F. M. Karmanov, and G. P. Maksimov. At. Energ. (USSR), 18: 273-5(Mar. 1965). (In Russian)

Experimental studies were made of the performance of a stellarator with magnetic fields of helical configuration symmetry. The shapes of magnetic surfaces with and without cylindricity are illustrated. The illustrations showed the distortions appearing in the absence of cylindricity. (R.V.J.)

25569 THE NATURE OF FLUCTUATIONS PRESENT IN d.c. PLASMA JETS IN ARGON AND NITROGEN. G. R. Jordan and L. A. King (Electrical Research Assn., Leatherhead, Surrey, Eng.). Brit. J. Appl. Phys., 16: 431-6(Apr. 1965).

The periodic fluctuations present in d-c plasma jets in argon and nitrogen were studied with a high-speed streak camera. An explanation for the nature of these fluctuations is given in terms of a process in which the arc column is continuously lengthening and short-circuiting. The amplitude and frequency of this column process is dependent upon the power dissipated in the jet, while the different forms in argon and nitrogen can be attributed to the differing anode-root mechanisms in these gases. On the assumption that the suggested arc column process occurs, the velocity of the jet was determined. (auth)

25570 THE DIFFUSION OF A HIGHLY IONIZED PLASMA ACROSS A MAGNETIC FIELD. O. D. Olson and H. M. Skarsgard (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 43: 855-71(May 1965).

The decay of electron density and temperature was measured in a low-pressure helium afterglow by means of

double floating probes of very small collection area. The plasma was contained in a glass toroidal chamber; initial gas pressures were in the vicinity of 0.030 torr. Magnetic confining fields from 0.004 to 0.0860 Wb/m^2 were used and the degree of ionization was such that coulomb collisions were dominant. Strict criteria were adopted to ensure reliable operation of the double probes. A theory of diffusion is presented, which includes interactions between all species of particles. Drift effects due to the inhomogeneous magnetic field are important at the higher field strengths and were taken into account. Reasonably good agreement was found between the theoretical and observed time constants for electron-density decay over a wide range of experimental conditions. (auth)

25571 CONTRIBUTION TO THE THEORY OF THE PROPAGATION OF ULTRASOUND IN AN IONIZED GAS (PLASMA). A. Adkhamov and A. Asrorov. Dokl. Akad. Nauk Tadzh. SSR, 7: No. 1, 16-21(1964).

The propagation of ultrasound in a plasma is considered on the basis of the Boltzmann-Vlasov gas-kinetic equations with simplified account of the collision term in accordance with the Fokker-Planck scheme. The distribution of the ions and the neutral particles is assumed to be Maxwellian, and the variation of the electron distribution function upon propagation of ultrasound in the plasma is taken into account by a gas-kinetic equation which is solved by the Grad method of moments. By approximating the distribution function with the first few terms of its expansion in Hermite polynomials, a finite system of differential equations is obtained for the unknown expansion coefficients, the hydrodynamic and transport equations for the components of the stress tensor and the heat flow are written down. These equations are then linearized under the assumption that the deviations of the medium in the ultrasound field from the equilibrium state are small. The case of propagation of a plane sound wave in a plasma is considered. The ultrasound velocity and the absorption coefficient are calculated as functions of the frequency. On approaching the plasma frequency from the higher-frequency side, the ultrasound velocity increases rapidly, tending asymptotically to infinity, while the absorption coefficient decreases to zero. Owing to the lack of experimental data, comparison of theory with experiment was not made. (CFSTI)

25572 PLASMA STATES— PHYSICS AND APPLICATIONS. Jon Arne Bakken (Universitetet, Bergen). Fra Fysik. Verden, 26: 63-6(1964). (In Norwegian)

Plasma and ionized gas are compared, and natural and artificial plasma are described. Theoretical considerations on the microscopic theory and the Boltzmann equation and on the macroscopic theory and magnetohydrodynamics are given. (J.S.R.)

25573 SPECTROGRAPHIC STUDY OF CHEMICALLY GENERATED CESIUM PLASMAS. Lawrence W. Fagg (Atlantic Research Corp., Alexandria, Va.). J. Quant. Spectry. Radiative Transfer, 5: 321-7(Mar.-Apr. 1965).

A spectrographic study was made of the cesium spectrum emitted in the burning of $CsNO_3$: Al and $CsClO_4$: Al mixtures. Line width measurements in conjunction with the line broadening theory of Griem for cesium yield a value of 2.5×10^{15} electron/cm^3 at atmospheric pressure for the $CsNO_3$: Al plasma. Although a value is also given for the case of the $CsClO_4$: Al plasma, it can only be considered as a rough estimate because the Griem theory is not applicable to this plasma due to the predominant concentration of Cl^- as a negative species. Theoretical values for the electron densities and densities of the major species of the two plasmas, assuming thermodynamic equilibrium, were computed and compared with the experimental values. (auth)

25574 INFLUENCE OF FIELD INHOMOGENEITY ON IONIC LINE BROADENING. Karl Gerhard Mueller (Universitat, Bonn and Lockheed Research Labs., Palo Alto, Calif.). J. Quant. Spectry. Radiative Transfer, 5: 403-23 (Mar.-Apr. 1965).

The usual calculation of the ionic line broadening assumes a constant electric field, acting on an emitting atom. For a many-electron atom, the quadratic Stark effect produces a shift proportional to $1/R^4$, where R is the distance perturber-atom. The actual Coulomb field of the ions possesses a field gradient, which for levels with a quadrupole moment causes a perturbation with $1/R^3$. For N independently distributed ions, the probability distribution of the field gradient is calculated. Three approximate cases are discussed: the nearest neighbor approximation, the approximation of spatially fixed eigenfunctions, and the nearest neighbor approximation of spatially fixed eigenfunctions. The line profile due to the quasistatic gradient of the field is calculated for these three assumptions. A critical density can be derived by comparing the effect of the field inhomogeneity with the quadratic Stark effect. Below this critical density, the effect of the field inhomogeneity dominates. For the example of neutral helium lines, the critical density is evaluated and goes up to 10^{16} to 10^{17} particles per cm^3. (auth)

25575 PROPAGATION IN NONUNIFORM GYROTROPIC MEDIA. Stanley H. Gross (Div. of Cutler-Hammer, Inc., Long Island, N. Y.) and Leopold B. Felsen. J. Res. Natl. Bur. Std., 69D: 333-48(Mar. 1965).

An E and H mode representation is used which results in a type of coupling independent of the rate of variation in the medium, thereby permitting the study of regions with strong inhomogeneities along the gyrotropic axis. The coupling between the E and H modes now arises due to the deviation of the gyromagnetic parameter $Y = \omega_c/\omega$ from zero or infinite values. The uncoupled problems are therefore associated with the nongyrotropic ($Y = 0$ or $Y = \infty$) but nonuniform cases, and the procedure converges rapidly when Y is large or small, even for rapid spatial variations of the medium parameters. An iterative expansion is employed to deduce the gyrotropic corrections, and the procedure is phrased systematically in transmission line form. The analysis is applied to the evaluation of the far field radiated by an electric current element exterior to a semi-infinite, nonuniform plasma region. (auth)

25576 ELECTROMAGNETIC FLUCTUATIONS IN AN EQUILIBRIUM PLASMA. Ronald E. Burgess (Univ. of British Columbia, Vancouver). J. Res. Natl. Bur. Std., 69D: 381-8(Mar. 1965).

The fluctuations in an electron-ion plasma in thermal equilibrium are first treated for the collisionless case. Separate consideration is given to the contributions of the transverse and longitudinal modes, and two approaches are used; one in terms of the energy density of the thermally excited plasma, the other in terms of the permittivity $\epsilon(K,\omega)$ appropriate to each mode. Some of the results have complete thermodynamic generality while some are based on the statistics of the plasma. Simple thermodynamic arguments are used to derive the radiation resistance of short electric and magnetic dipoles in a collisionless plasma. The relation between the spatial correlation properties of the longitudinal mode and Debye-Hückel theory is indicated. It is shown that in a plasma with collisions the fluctuation temperature is equal to the common electron-ion temperature for any degree of degeneracy and any velocity dependence of relaxation time. (auth)

25577 ELECTRODYNAMICS OF MOVING ANISOTROPIC MEDIA: THE FIRST-ORDER THEORY. C. T. Tai (Univ. of Michigan, Ann Arbor). J. Res. Natl. Bur. Std., 69D: 401-5(Mar. 1965).

Minkowski's theory of moving media is extended to the anisotropic case. The corresponding Maxwell-Minkowski equations were derived under the condition that the velocity of the moving medium is small compared to the velocity of light. As an application of that theory, it is shown that the characteristics of a plane wave propagating in a drifting magneto-ionic plasma can be determined from the constitutive parameters of the plasma without drifting. The equivalence between the convection current model adopted by Bell and Helliwell and the polarization current model suggested by Unz and correctly interpreted by Epstein, Bell, Smith, and Brice is also pointed out. (auth)

25578 SHEAR INSTABILITY IN A CURRENT-CARRYING PLASMA. A. Caruso and F. Gratton (Comitato Nazionale per l'Energia Nucleare, Rome). Nuovo Cimento (10), 37: 62-75(May 1, 1965).

The shear instability of a spatially dependent electron current flowing in a plasma, against electrostatic perturbations, is investigated. Upper bounds for the growth rates under general conditions for the velocity profile are given. The stability of some particular flows is analyzed. The effects of a velocity dispersion in the direction of the flow are also considered. (auth)

25579 LINEAR OSCILLATIONS IN RELATIVISTIC PLASMAS. F. Santini (EURATOM-CNEN, Frascati, Italy) and G. Szamosi. Nuovo Cimento (10), 37: 685-97(May 16, 1965).

The theory of the linear oscillations in a relativistic Maxwellian plasma is developed in detail. Collisions and external fields are not considered. The frequency and the damping constants of the longitudinal modes were calculated exactly. Also the oscillations of a system of a high-energy cold electron beam and relativistic Maxwellian plasma were studied in detail. (auth)

25580 APPLICATION OF HOLLOW PROBES IN AN OPENING TO THE STUDY OF ELECTRICAL DISCHARGES IN A GAS. A. Pozwolski (Universite, Paris). Onde Elec., 45: 240-5(Feb. 1965). (In French)

The theory of probes is outlined with consideration of the analogy between ion sources and probes. The application of hollow probes to the study of high-frequency electric discharges and of the electric discharge in ozonizers is treated in detail. (D.C.W.)

25581 TEMPERATURE DETERMINATION OF PLASMAS PRODUCED BY GIANT LASER PULSES. H. Opower and E. Burlefinger (Technische Hochschule, Munich). Phys. Letters, 16: 37-8(May 1, 1965).

A method for determining the temperature of plasmas produced by focusing a ruby laser pulse on a solid carbon target is described. The experimental arrangement is shown. (L.B.S.)

25582 MAGNETIC FIELDS FOR PLASMA PHYSICS EXPERIMENTS. W. F. Gauster (Oak Ridge National Lab., Tenn.). Physik. Bl., 20: 163-72(1964). (In German)

The calculation of magnetic fields with known current distributions, field synthesis, trajectory calculations of charged particles in magnetic fields, and the calculation and technology of magnetic coils are briefly reviewed. (J.S.R.)

25583 ADVANCES IN FUSION RESEARCH. Albert Simon (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Proc. Natl. Acad. Sci. U. S., 53: 866-73(Apr. 1965). (GA-5283)

The experimental verification by Toffe in the Soviet Union of the flute instability of a plasma in a mirror geometry and of suppression of the instability by a reversed field gradient is reviewed, together with some observations of the flute instability in the United States. (D.C.W.)

25584 STUDIES OF ELLIPTICAL POLARIZATION OF WEAK MAGNETOHYDRODYNAMIC WAVES. R. V. Deutsch and M. Cristea. Studia Univ. Babes-Bolyai, Ser. Math.-Phys., No. 2, 95-9(1964). (In Rumanian)

The character of magnetohydrodynamic waves when they have a direction very close to the direction of the external magnetic field is studied. In this case (as in the case of low frequencies) two circularly polarized waves and a longitudinal wave are obtained. The critical region, when the Alfven velocity is very close to the velocity of the acoustic waves, is analyzed in more detail. (tr-auth)

25585 ON THE LONGITUDINAL INSTABILITY IN ONE-DEMENSIONAL CONDUCTING GAS FLOW. E. V. Artyushkov and A. I. Morozov. Teplofiz. Vysokikh Temp., 2: 525-34(1964).

The stability of longitudinal oscillations in compressible, electrically conducting gas under a transverse magnetic field was studied analytically. The flow is assumed to be inviscid and in a channel slowly varying in cross section. Furthermore, the gas is assumed to have finite electric and thermal conductivities. The analysis is carried out by means of expansions in the small parameter λ/L where λ = oscillation wavelength and L = length of channel. The hydrodynamic equations are written for a fully ionized gas with $T_i = T_e$. Ohmic and viscous dissipations are neglected and the equations are then nondimensionalized by means of the parameters $(x/L) = \xi$, $(tc_*/L) = \tau$, $(v_0/c_*) = V$, where C_*-flow velocity in critical section. The oscillations in the various parameters in the channel are described by functions of the form $F = F(\xi)\exp(i\beta\tau)$ where $\beta = \omega L/c_*$. Two limiting cases are considered only: diffusion terms much higher than convection terms in the energy equation and $H_1/H_0 \sim 1/\beta$, $\beta \gg 1$ (H—magnetic field); the amplitude of hydrodynamic pressure oscillations much larger than the amplitude of magnetic pressure oscillations. These two cases are studied under the assumption of quasi-isothermal and quasi-adiabatic oscillations. In the former, $T_1/T_0 \sim 1/i\beta$ and solutions are obtained for $V = 0$ and $V_0 \gg C\rho$ ($c\rho^2 = \gamma RT_0/M$) up to order $1/i\beta$ in the expansion. The instability condition appears under $C_A \gg C_T$ ($C_A^2 = H_0^2/4n\rho_0$) and is given by $\sqrt{\gamma}H_0' > (\gamma - 1/\gamma)(c_T^2/c_A^2)Pe_T + Re_T$. For the quasi-adiabatic approximation, $T_1/T_0 \sim \rho_1/\rho_0$, the stability criterion is given by $(H_0'/Re_T) > (1/\gamma - 1) \times (H_0'/Re_T) < [1/\gamma - n(\gamma - 1)]$. This indicates that instability arises from waves travelling against the flow as well as along the flow. Several examples are given to illustrate these points. (CFSTI)

25586 STATIONARY AND NONSTATIONARY PROCESSES IN A NONEQUILIBRIUM PLASMA. K. N. Ul'yanov (All-Union Electrotechnical Inst., USSR). Teplofiz. Vysokikh Temp., 2: 842-51(1964).

A theory is proposed for calculating the distribution of atoms and ions along discrete states and continuous energy spectra at stationary and nonstationary conditions. The differential equation governing the time development of nonequilibrium states is reduced to a first-order equation which can be solved numerically. The distribution of atoms and ions along the various energy levels at equilibrium is given by the Boltzmann-Katz equation. The kinetic equation for the electron distribution function was obtained by Ginzburg and Gurevich in the form $(1/2v_2)\partial/\partial v)v^2\{\delta^{\gamma}(\nu_m^{\gamma} + \nu_i^{\gamma})[vf + (kT_e/m)\partial f/\partial v)] - (\delta/2)(e\bar{E}u/m)\partial f/\partial v) + 2[A_1(f)vf + A_2(f)\partial f/\partial v)]\} + S^{Hy}(f) = 0$, where f is the distribution function, v the velocity, ν_m^{γ} the frequency of elastic collisions of electrons with the atoms of the m-th species, ν_i the frequency of electron-ion collisions, ν_{ee} the frequency of electron-electron collisions, and $\delta^{\gamma} = (2m/M)$. Using the principle of detailed balance, S^{Hy} can be written in the form $S^{Hy} = -n_1 v\sigma_{12}(v)[f(v) - (y_2/y_1)f^M(v)]$, where σ_{12} is the cross section for electron collisions in a stationary state, and f_M is the Maxwell distribution. If y_k is the concentration of the k-th species of atoms, f can be written in the form $f = f^M\{(y_2/y_1) + [1 - (y_2/y_1)]e^{-B(x)}\}$. For the nonstationary case, the following equation was obtained for the rate of change of electron concentration: $(\dot{n}_e/n_e) = (\dot{T}_e/T_e)[\sum n_k(u_k + 1.5)]/2\sum n_k + n_e$, $u_k = E_k/kT_e$. Here E_k is the energy of the k-th bound state of an electron. Typical numerical calculations are presented for a cesium-argon mixture corresponding to three different values of the argon concentration. (CFSTI)

25587 SPECTROSCOPIC MEASUREMENTS ON MEMBRANE SHOCK WAVE TUBES. PART I. ABSOLUTE DETERMINATION OF THE CONTINUOUS ABSORPTION COEFFICIENT OF NEGATIVE HYDROGEN IONS. A. Boehm and L. Rehder (Universitat, Kiel). Z. Naturforsch., 20a: 114-20(Jan. 1965). (In German)

By photoelectric intensity measurements on a krypton-hydrogen plasma produced by a membrane shock wave, the continuous absorption coefficient of negative hydrogen ions in the visible spectral range was determined absolutely. The entropies of the plasma were calculated from the measured collision wave velocities and the entropy before the wave front. (tr-auth)

25588 SPECTROSCOPIC MEASUREMENTS ON MEMBRANE SHOCK WAVE TUBES. PART II. ABSOLUTE DETERMINATION OF THE ξ-FACTOR OF NEUTRAL RARE GAS ATOMS. O. E. Berge, A. Boehm, and L. Rehder (Universitat, Kiel). Z. Naturforsch., 20a: 120-4 (Jan. 1965). (In German)

By photoelectric intensity measurements on a plasma heated by a membrane collision wave, the continuous absorption coefficients and therefore the ξ factors of the neutral atoms of argon, krypton, and xenon were absolutely determined in the visible spectral range. The entropies of the plasmas were calculated from the measured collision wave velocities and the entropies before the wave front. (tr-auth)

25589 ON A PLASMA MICROFIELD. K. Hunger, R. W. Larenz, and K. Wilke (Technische Hochschule, Hanover). Z. Naturforsch., 20a: 158-9(Jan. 1965). (In German)

A numerical experiment using the CDC 1604 A electronic computer to test existing microfield theories is described. The microfield distribution is normalized representation, the Holtsmark distribution, and the distribution observed on the computer are graphed and discussed. (J.S.R.)

25590 SPECTROSCOPIC INVESTIGATION OF A HYDROGEN AND HELIUM PLASMA IN A P.I.G. DISCHARGE. H. W. Drawin, M. Fumelli, and G. Weste (Euratom-CEA, Fontenay-aux-Roses, France). Z. Naturforsch., 20a: 184-92(Feb. 1965).

The intensities of spectral lines emitted from a low pressure PIG discharge in hydrogen and helium gas were measured, and the population densities of the corresponding excited levels were calculated. It was found that the population densities of the excited states do not follow the values given by the Saha equation. The probable reason for this deviation is the influx (or diffusion) of the neutral atoms into the plasma column. A model which takes into account the free diffusion of the surrounding gas atoms into the plasma column permits an explanation of the observed phenomena. Using this model and solving the corresponding rate equations, electron temperatures of several electron volts were obtained for both gases. These temperatures are confirmed by mass spectrometric abundance measurements of the He^+-and He^{2+}-ions, in conjunction with the coronal ionization formula. (auth)

25591 DETERMINATION OF TEMPERATURE IN A TOROIDAL THETA PINCH DISCHARGE WITH AN IMAGE CONVERTER CAMERA. P. C. T. van der Laan and R. Mewe (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Z. Naturforsch., 20a: 193-6(Feb. 1965).

Using an image converter camera streak pictures were made of toroidal Θ-pinch discharges in helium at pressures ranging from 0.01 to 0.06 torr. The discharges are produced by a capacitor bank of 2.5 kjoule. From the pictures the acceleration of the outward drifting plasma column and the drift time (1 to 2 μsec) were measured. From these quantities the mean plasma temperature after the compression was determined. The temperature depends on the pressure and varies from about 5×10^{5}°K at 0.01 torr to 10^{5}°K at 0.06 torr. These results are compared with temperatures calculated from the irreversible heating during the compression. From spectroscopic measurements of the intensities of He II λ = 4686Å and He I λ = 5015 Å, the electron temperature is estimated; and the assumption of complete ionization is checked. (auth)

25592 INTERFEROMETRIC INVESTIGATIONS OF ELECTROMAGNETICALLY ACCELERATED SHOCK WAVES. H. Brinkschulte and H. Muntenbruch (Institut fur Plasmaphysik, Garching, Ger.). Z. Naturforsch., 20a: 196-202(Feb. 1965). (In German)

The phenomena of shock waves generated electromagnetically in T-tubes were studied with a Mach-Zehnder interferometer. The measurements were made in hydrogen at initial pressures from 2.5 to 10 mm Hg. Shock velocity varied between Mach 6 and Mach 20. It was found that there are two fronts: the luminous front due to the discharge plasma and the non-luminous shock front in front of this. The distance between the shock front and the luminosity front decreases with increasing velocity. At vS ≙ Mach 20, the luminosity front reaches the shock front. Shock fronts are always plane. The density decreases directly behind the shock front. The shock waves thus formed can not be described with the Rankine–Hugoniot equations. At small velocities, the density jump is 6; at higher velocities the gas is dissociated. The refractive index of atomic hydrogen can be measured. Simultaneously the selection of the computational method used to describe the shock conditions in hydrogen can be justified. Precursor effects have no influence, relaxations could not be seen. (auth)

25593 MEASUREMENTS ON A STABLE AND UNSTABLE MODE OBSERVED IN A LITHIUM REFLEX ARC. H. W. Drawin and M. Fumelli (EURATOM-CEA, Fontenay-aux-Roses, France). Z. Naturforsch., 20a: 445-51(Mar. 1965).

A powerful P.I.G. reflex arc in lithium vapor was studied using spectrographic, mass spectrometric, and probe measuring techniques. The Li vapor was produced in a special Li oven; the vapor entered through a small tube directly into the hollow anode cylinder. The residual gas pressure was 10^{-7} mm Hg with the arc in operation, the density in the plasma column was about 10^{13} cm^{-3}. The discharge showed two different modes of operation. It was observed that at a fixed flow of Li vapor the discharge can be operated in a stable state (Mode I) only below a certain limit of the applied electrical power. An increase of electrical power (or a decrease of the flow of Li vapor) caused a strong instability (Mode II). Mode I showed the discharge column to be very well stabilized by the confining magnetic field. Electrostatic probe measurements showed no voltage fluctuations. The electron temperature ranged from 1.8 to 8 ev, depending on the electrical power applied. Mode II showed the plasma column as diffuse. Large voltage fluctuations of several volts in the megacycle region could be detected on the electrostatic probe. A powerful flux of ions leaving the plasma column perpendicular to the magnetic lines of force and hitting the walls with energies up to 327 ev was measured. These energetic ions were responsible for the strong light emission of the walls of the vacuum tube, this light intensity being much higher than the intensity of the plasma column. The experimental results were similar to those observed by Neidigh, Weaver, Nezlin, and Solntsev under different experimental conditions. (auth)

25594 RECOMBINATION AND DIFFUSION WITH DEPENDENCE ON ELECTRON TEMPERATURE OF A DECAYING NEON PLASMA. Walther Hess (Technische Hochschule, Stuttgart). Z. Naturforsch., 20a: 451-7(Mar. 1965). (In German)

An experimental investigation was made of the electron temperature dependence of the ambipolar diffusion coefficient as well as the electron-ion recombination coefficients in the afterglow of plasmas produced in neon. By means of a microwave-cavity technique the electron density was measured as a function of time during the afterglow period of a d-c discharge while at the same time the electron energy was increased by the power level of a microwave signal. It was found that the ambipolar diffusion coefficient D_a increases with increasing electron temperature T_e following the well-known relation: $D_a \propto (1 + T_e/T_g)$, while the recombination coefficient α decreases with increasing electron temperature. The dependence of α on electron temperature was found to be: $\alpha \propto T_e^{-0.4}$ from 900 to 2400°K, while a weaker dependence in the range of $\alpha \propto T_e^{-0.25}$ was measured in the lower temperature region from 300 to 600°K. At 300°K the recombination coefficient in neon was found to be $\alpha = 2.0 \times 10^{-7}$ cm^3 sec^{-1}. All measurements were made at electron densities of $\sim 10^9$/cm^3 and gas pressures of 1 mm Hg (diffusion) and 20 mm Hg (recombination). (auth)

25595 ON THE DETERMINATION OF TEMPERATURE AND VELOCITY OF THE PLASMA FLOW FROM A PLASMA JET. B. Ahlborn (Institut fur Plasmaphysik,

G.m.b.H., Garching, Ger.). Z. Naturforsch., 20a: 466-74 (Mar. 1965). (In German)

A two-step model of the heating processes in a plasma jet is given. In this model, a hot interior and colder sheath was postulated, and the conservation theorems for mass, momentum, and energy were solved so that the plasma velocity and temperature could be calculated if the power supply, pressure drop over the heating length, and the cross-sectional area of the luminous plasma stream were known. The accelerating action of the electromagnetic forces was considered as well as the Joule heating caused by the arc current. This model was tested using a method to measure the average velocity and using spectroscopy to measure the temperature of the plasma jet. The applicability of the "two step" model is shown by these experiments. (auth)

25596 THE ENERGY BALANCE OF A HYDROGEN ARC IN AN AXIAL MAGNETIC FIELD. Udo Heidrich (Institut fur Plasmaphysik, G.m.b.H., Garching, Ger.). Z. Naturforsch., 20a: 475-84(Mar. 1965). (In German)

The numerical solution of the energy balance of a cylindrically symmetric hydrogen arc immersed in an axial, strong, homogeneous magnetic field led to the current-voltage-characteristic and the radial temperature, distribution. Three types of arc models were used, each with different assumptions of radiation losses. The results showed that, by the reduction of the thermal conductivity perpendicular to the magnetic field for a fully ionized plasma, the necessary electrical power is diminished for temperatures along the axis higher than about 2×10^4°K. For example, an arc with 1-cm radius in a hydrogen atmosphere of 5×10^4 dyne/cm^2, in an external magnetic field of 20 kG, a temperature along the axis of 10^5°K requires about 3.5 kw per cm arc length. Of this, radiation losses account for about 0.5 kw per cm. However, without a superimposed magnetic field the electrical power is about 200 kw per cm. (auth)

25597 SOME NONLINEAR PROBLEMS IN PARTIALLY IONIZED GASES. Edward Charles DuFort. Thesis, Los Angeles, Univ. of Southern California, 1964. 249p.

A theoretical study of harmonics arising from nonlinear dissipation in a plasma is presented. The subjects treated fall into one of three overlapping topics: the kinetic theory of plasmas, the development of accurate nonlinear macroscopic equations linking the important average quantities (current, electron temperature, etc.) together, and application of the macroscopic equations to nonlinear problems involving harmonics. The first topic is primarily a review of the literature, intespersed with critical commentary, expanded discussion, and alternative and clearer derivations of important relations. In the second topic, the macroscopic equations for the plasma, simple equations for the important quantities such as the electron current and electron temperature, are developed directly from the kinetic theory. In the third topic, the macroscopic approach is applied to two nonlinear problems. The first is a study of the low-frequency nonlinear current flow associated with the monochromatic electric field of arbitrary intensity. Important harmonics of the fundamental current are found in terms of well-known functions. In the second nonlinear problem, a monochromatic field is incident upon a semi-infinite plasma slab and the back radiation from the interface, and the nature of the field within the plasma is sought. Approximate numerical methods are required to solve this problem. A hierarchy of approximations is discussed, and extensive numerical calculations are carried out using the simplest approximation. Strong harmonics of the fundamental are found to propagate deep within the plasma. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25598 THE MAGNETIC STABILIZATION OF AN ELECTRIC ARC IN SUPERSONIC FLOW. Charles Eugene Bond. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 209p.

A method is presented for the magnetic stabilization of a high-current d-c electric arc in a transverse supersonic air flow. It is shown that the arc can be successfully held in the flow by this method in such a way that spatial and temporal fluctuations in the positive column are not in evidence. Significant observations are presented of arc behavior under this mode of confinement, including the observation that the stable supersonic arc is characterized by a positive column slanted with respect to the electric field and that forced departures from the slanted configuration result in column instability. The experimental setup consists of two rail electrodes mounted in a supersonic wind tunnel and oriented parallel to the tunnel free-stream. External coils provide a transverse magnetic field mutually perpendicular with the electric field and free-stream. The coils are placed such that there is a monotonic increase in magnetic flux density from the upstream to the downstream end of the rails. The arc is initiated by means of an exploding wire between the upstream ends of the rails. The plasma column is generated then moves under the action of aerodynamic and electromagnetic forces until a location and orientation are reached where these forces come into balance. The stable arc column remains locked in at this location until the current is shut off. Stabilization is achieved primarily through dynamic processes in the positive column; and for a given current and magnetic field, arc location is determined by the location of the external field coils and by free-stream conditions, independent of the electrode material and of disturbances to the flow near the cathode surface upstream of the cathode root. Stability in the streamwise direction results from the increase in Lorentz force with downstream displacement. (A.G.W.)

25599 AN INTRODUCTION TO GAS DISCHARGES. A. M. Howatson. Applied Electricity and Electronics Division. Volume 8. Oxford and New York, Pergamon Press, 1965. 242p. $3.75.

A survey on the theory of electric discharges in gases is presented, covering fundamental processes, breakdown, self-sustaining discharges, equilibrium, and plasma measurements and properties. Applications of electric discharges are also discussed. (D.C.W.)

25600 ON A NEW PERTURBATION METHOD. Richard Yee Yen Lee. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 124p.

The spirit of this new method is to avoid unnecessary secular terms caused by the perturbation procedure itself. The formal derivation of the perturbation recipe is presented in Chapter 2, in which both the case of finite degrees of freedom and the cases with infinite or continuous degrees of freedom are discussed. Chapter 3 is devoted to the application to problems with finite degrees of freedom. Attention is also paid to problems that possess real secular terms (secular terms that are not caused by the perturbation procedure). Chapter 4 is a brief review of the ordinary Rayleigh-Schroedinger perturbation formulas of ordinary quantum mechanics from the standpoint of our new perturbation method. Chapter 5 deals with problems with continuous degrees of freedom. The property of irreversibility is shown to be a consequence of the perturbation. Chapters 6 and 7 deal with the problem of termination of the B-B-G-K-Y hierarchy to form the kinetic equations. Chapter 6 deals with the classical hierarchy, whereas Chapter 7 deals with the quantum mechanical hierarchy. The parameters of smallness used in the perturbation are the coupling constant and the average density. In Chapter 7, attention is also paid to the effect of symmetries. Finally, the application of the method to the problems of plasmas is prospected. (Dissertation Abstr., 25: No. 6, Dec. 1964).

25601 THE SOLUTION OF THE KINETIC EQUATION FOR AN UNSTABLE PLASMA IN A D.C. ELECTRIC FIELD. Edward Clifton Field, Jr. Thesis, Los Angeles, Univ. of California, 1964. 136p.

An approximate form of the kinetic equation, applicable when interactions between particles and unstable waves have become much more important than Coulomb encounters between pairs of particles, is derived. This equation is used to study the dynamics of a fully ionized,

spatially homogeneous plasma in a d-c electric field. Two methods are used to obtain, among other things, the time-dependent plasma current and heating. In the first method, the electron and ions are assigned Maxwellian one-body velocity distributions, which are displaced from each other by their relative drift velocity. These distributions are characterized by temperatures different in the directions parallel and perpendicular to the external electric field. These time-dependent currents and temperatures are then self-consistently determined by numerically solving the equations obtained by taking the appropriate velocity moments of the kinetic equation. The second method of solution involves the assumption that the velocity distributions are Maxwellian only in the direction perpendicular to the external electric field. The kinetic equation for the part of the distribution parallel to the external field is then solved numerically. Both methods of solution are applied to the physically interesting case where the electrons are much hotter than the ions. Both methods predict that after an initial increase, which is linear in time, the current reaches a peak and then decreases substantially. Also, in both cases, the non-linear, unstable waves affect the velocity distributions in such a way as to eventually render themselves stable. It is found that, in the moment approximation, the most important waves are those that propagate along, or nearly along, the external electric field. The more general treatment predicts that waves that propagate obliquely to the external field eventually become dominant. (A.G.W.)

25602 THEORY OF RAREFACTION WAVES IN A PLASMA. Grady Ward Paxton, Jr. Thesis, Norman, Okla. Univ. of Oklahoma, 1964. 83p.

A theory for the rarefaction process in a plasma carrying an electric current is developed for the one-dimensional case. General criteria are derived, which determine the nature of the rarefaction process as a function of the electron temperature and degree of ionization in the plasma. The analysis shows that under certain conditions the rarefaction wave is a rarefaction shock. It is shown that the existence of such a wave is the result of the energy balance required by electrical current conservation in the electron gas of a plasma in which the electrons are the principal plasma-motive agent. Thus the characterization of the type of rarefaction process present in a plasma is shown to be critically dependent on the microscopic interactions between the electrons and the massive particles in the plasma. The theory is applied to the expansion process in a strongly ionized hydrogen plasma where it is shown that rarefaction shocks indeed exist for certain values of the electron temperature and degree of ionization. The theory is also applied to the rarefaction wave in the driver section of the electric shock tube in order to determine the velocity of the compressional shock produced in terms of the electron temperature, degree of ionization, and plasma density in the driver section. Finally, the effects of the electric microfields on the rarefaction wave in a plasma are analyzed for the cases of isentropic and isothermal expansions. The rarefraction waves in an isentropic expansion are shown to be simple waves always; whereas the rarefaction waves in an isothermal expansion are shown to be in some cases rarefaction shocks. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25603 ELECTRON DENSITY DEPENDENCE OF CYCLOTRON HARMONIC RADIATION FROM A PLASMA. C. D. Lustig (Sperry Rand Research Center, Sudbury, Mass.). 12p. (CONF-641108-32)

From American Physical Society, New York.

Simultaneous measurements of electron density and radiation emitted near harmonics of the electron frequency were made with a microwave cavity coaxial with a low-pressure argon discharge in a magnetic field. The dependence of the line position and width on electron density is in reasonable agreement with recent calculations made of the spectrum of electrostatic waves excited by fast electrons. The intensity of the radiation increased rapidly with electron density, and no radiation was observable unless the maximum hybrid frequency in the column was close to or greater than the frequency of observation. (auth)

25604 EFFECTIVE TRANSPORT COEFFICIENTS AT LOW AND HIGH COLLISION FREQUENCIES. O. Buneman (Stanford Univ., Calif.). 10p. (CONF-641108-17)

From American Physical Society, New York.

It has been found possible to employ gasdynamical concepts and terminology for the description of a plasma even at low and vanishing collision frequencies. The plasma must be near thermal equilibrium and nearly uniform. It must be treated as a gas mixture (neutrals, ions, electrons) each component having its "effective" coefficients of specific heat, viscosity, thermal conduction and Van der Waals force. The components are brought into interaction by momentum and energy exchange terms, the macroscopic Coulomb interaction being included here as a link between ions and electrons. The four transport coefficients are functions of the wave number and frequency of the deviations from thermodynamic equilibrium. The exact functional dependence is determined by the choice of a model for the collision term, such as B-G-K or Fokker-Planck. Formulas valid at all values of collision frequency are obtained from these models; and in the limits of high and zero collision frequencies, one finds the correct dispersion laws for sound waves, ion waves and (Landau-damped) plasma oscillations. (auth)

25605 GYROTROPIC RESONANCES IN AFTERGLOW PLASMAS. H. J. Schmitt, G. Meltz, and P. J. Freyheit (Sperry Rand Research Center, Sudbury, Mass.). 13p. (CONF-641108-15)

From American Physical Society, New York.

Observations of the reflection of radio waves from a decaying plasma column contained in a steady axial magnetic field exhibit a repetitive pattern of resonances as the ratio of radio frequency to electron cyclotron frequency is varied through successive harmonics. The resonances are interpreted as weakly damped electron plasma oscillations. The observations are compared with a resonance spectrum obtained from a model in which WKB techniques are used in conjunction with the Bernstein dispersion relation for a dissipation-free plasma. The connection between the zero-field electroacoustic resonances in the plasma sheath and the gyrotropic resonances in the plasma core for frequencies near the cyclotron harmonic is also discussed. (auth)

25606 EXCITATION OF ELECTROSTATIC WAVES NEAR ELECTRON CYCLOTRON HARMONIC FREQUENCIES. P. M. Stone and P. L. Auer (Sperry Rand Research Center, Sudbury, Mass.). 29p. (CONF-641108-31)

From American Physical Society, New York.

The problem considered is that of excitation of electrostatic waves in a plasma in a magnetic field by non-relativistic fast electrons. The plasma is assumed to be uniform and to have a velocity distribution that differs slightly from Maxwellian by the presence of the fast electrons. Collisions and ion motion are neglected. The "dressed" test particle approach is used to calculate the electric field in the plasma associated with the fast electrons and, from this, the energy lost by the fast electrons. The Fourier decomposition of the energy loss rate gives the spectrum. The electrostatic dispersion relation limits the emission (by Landau damping) to directions nearly perpendicular to the magnetic field. Solutions of the dispersion relation for these directions are presented, and typical emission lines for monoenergetic fast electrons are shown. For a suitable choice of fast electron velocities, the positions and widths of the peaks are shown to agree with experimental observations of electromagnetic emission. (auth)

25607 NEGATIVE HIGH-FREQUENCY CONDUCTIVITY IN A FULLY IONIZED PLASMA. E. H. Klevans, J. R. Primack, and C.-S. Wu (California Inst. of Tech., Pasadena). 35p. (CONF-641108-38)

From American Physical Society, New York.

The plasma kinetic equation with dynamic shielding is used to compute the high-frequency conductivity of a plasma, the unperturbed state of which is different from

thermodynamic equilibrium. Two specific cases are considered in detail: in the first, the unperturbed plasma has different electron and ion temperatures; in the second, the unperturbed plasma is characterized by a relative drift between electrons and ions. For the first case, it is found that, if the electron temperature T_e and ion temperature T_i are sufficiently different (T_e/T_i or T_i/T_e of the order of 10^4), the real part of the conductivity becomes negative. For the second case, it is found that, if the electron drift exceeds 1.37 times the electron thermal speed, and if $T_i > 1.07\ T_e$, negative conductivity results. If $T_i < 1.07\ T_e$, the drift which will produce an instability is smaller than the drift required to produce negative conductivity; consequently, the analysis which indicates the existence of negative conductivity is no longer valid. (auth)

25608 THEORY OF A POSITIVE COLUMN AS A RESONANT SCATTERER. R. L. Moore (Douglas Aircraft Co., Inc., Long Beach, Calif.). 14p. (CONF-641108-35)

From American Physical Society, New York.

An analysis was made of the "anomalous dispersion" of a plasma column by a method similar to Lorentz' for molecular anomalous dispersion. The plasma electrons are subject to a radial d-c electric field which gives rise to vibrational resonances. To obtain the polarization field of a plasma at such a resonance, the field inside and outside the plasma was calculated; boundary conditions were applied at the axis, at the plasma surface, and at infinity. Assuming an approximate solution to the equation of motion and Poisson's equation for a non-uniform medium, the near radial electric field outside the plasma is given by the following expression multiplying the incident field: $1 + r^{-2}\{r_1^2 - i \Sigma C_n (\omega_n^2 - \omega^2 - i\omega\nu)^{-1}\}$, where C_n are coupling coefficients determined by the plasma properties and the test frequency; ω_n are the set of resonant frequencies for radial vibrational motion; r is the radial distance in cylindrical coordinates; and $1/\nu$ is a dissipation time. (auth)

25609 COLLISION CONTROLLED STABILITY OF A PLASMA DIODE. Louis Gold (Stevens Inst. of Tech., Hoboken, N. J.). 23p. (CONF-758-7)

From American Physical Society Meeting, New York, Jan. 1965.

A plasma diode in which the electron motion is impeded by Coulomb scattering is investigated. A characteristic equation containing information concerning the stability of the system is deduced for several states, including the weakly damped case. Stable d-c performance can be maintained when there is sufficient damping and currents drawn. It is conjectured that a coupling of noise fluctuations with the collective longitudinal oscillations can arise to provide a noise modulated a-c output, and that the noise is of thermal origin. The theory represents the beginning of a dynamic approach to noise in ionized media and provides the foundations for a transport (irreversible thermodynamics) description of fluctuation phenomena associated with noise. (L.B.S.)

25610 THE END STABILIZATION EFFECT AND INSTABILITIES IN SLOW THETA PINCH PLASMA. Haruyuki Ohnishi (Nihon Univ., Tokyo). 24p. (CONF-641108-44).

From American Physical Society, New York.

The results of an experimental investigation of the stability of plasma in a slow theta pinch are presented. A model for the observed end stabilization effect is proposed, and it is concluded that the stability of the plasma in a mirror configuration depends on the end stabilization effect. (D.C.W.)

25611 INSTABILITY OF BEAM-PLASMA SYSTEM NEAR THE CYCLOTRON HARMONICS. S. Gruber (Sperry Rand Research Center, Sudbury, Mass.). 4p. (CONF-641108-43).

From American Physical Society, New York.

The propagation of electrostatic waves on electron beams immersed in a warm plasma is investigated, taking into account collisional losses. Of particular interest are resistive instabilities near the cyclotron harmonics. Mode coupling from a plasma column supporting electrostatic waves and a surrounding waveguide is considered. (D.C.W.)

25612 SPECTRA OF MULTIPLY IONIZED ATOMS IN LASER HEATED PLASMAS. E. Archbold and T. P. Hughes (National Physical Lab., Teddington, Middx., Eng.). 18p. (CONF-641022-1).

From Optical Society of America, Annual Meeting, New York.

Plasmas formed by focusing a high power neodymium glass laser beam on to carbon and boron targets were studied spectrographically. The most highly ionized atoms detected with a quartz prism spectrograph belonged to the HeI isoelectronic sequence, CV and BIV lines being recorded. On the assumption of a Maxwellian distribution of electron velocities the peak electron temperatures were estimated from the intensities of these lines to be about 1 to 2×10^{5}°K in the carbon plasma and about 10^{5}°K or higher for the boron plasma. The electron and ion densities were of the order of 10^{18} to 10^{20} cm^{-3}. The breadth of the BIV lines showed that the ion temperature in the boron plasma did not exceed 6×10^{5}°K: it was probably close to the electron temperature. Free-free transitions by electrons in the field of positive ions is an effective mechanism for laser light absorption in the plasmas investigated. (auth)

25613 WEAKLY IONIZED NONEQUILIBRIUM VISCOUS SHOCK LAYER AND ELECTROSTATIC PROBE CHARACTERISTICS. Paul M. Chung (Aerospace Corp., San Bernardino, Calif.). 37p. (CONF-641119-2).

From American Physical Society, Division of Fluid Dynamics, Pasadena, Calif.

The electro-chemical interactions between the hypersonic stream of weakly ionized gases and the stagnation region of electrically biased blunt bodies are analyzed. Tha analysis is based on a continuum description. From the study, typical current-potential relations for electrostatic stagnation probes are obtained. The effects on the electrical characteristics of the finite rate collisional energy exchange between electrons and neutrals, and the nonequilibrium electron-ion recombination are studied. Particular attention is given to the electron temperature variations in the free stream, shock, and the shock layer. Among other things, it was found that the classical electron saturation current is not usually attained. (auth)

25614 IMPROVEMENTS IN OR RELATING TO PLASMA RESEARCH APPARATUS. (to General Dynamics Corp.). British Patent 967,430. Aug. 19, 1964. Priority date Aug. 20, 1962, United States.

The apparatus consists of a generally tubular jacket of conductive material providing means for interconnected convex and concave magnetic confining fields about an area where the plasma is to be confined. The jacket is internally fluted to provide a plurality of generally longitudinal, arcuate ridges and grooves. An elongated conductive member disposed in each groove in spaced relation to the groove wall provides in addition a convex field within each concave one so that the plasma is completely encircled by a series of convex fields. In order to stabilize the plasma, the total magnetic field strength between the means for providing the concave fields and that for providing the convex fields within the concave ones is made substantially greater than the means for providing the convex fields that interconnect with the concave ones. (B.L.M.)

Shielding

Refer also to abstract 25547.

25615 (AED-C-01-08) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. BAUWESEN. STRAHLENABSCHIRMUNG TEIL III. ABSCHIRMUNG VON GAMMA- UND NEUTRONENSTRAHLUNG; THEORIE UND EXPERIMENT. (Selected Literature According to Subject. Building Materials. Radiation Shielding. Part III. Shielding of Gamma- and Neutron Radiations; Theory and Experiment).

(Fraunhofer-Gesellschaft, Stuttgart (West Germany)). 1964. 253p. Dep.(mn).

About 232 references are presented to theoretical and experimental research on the attenuation of gamma and neutron radiations in materials. Author, report number, and subject indexes are included. (D.L.C.)

25616 (ORNL-TM-973) A CALCULATION OF THE NEUTRON DOSE IN ORDINARY CONCRETE DUE TO AIR-SCATTERED NEUTRONS FROM A POINT FISSION SOURCE. D. K. Trubey (Oak Ridge National Lab., Tenn.). Mar. 15, 1965. Contract [W-7405-eng-26]. 12p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

A calculation of the fast-neutron dose in concrete due to a point fission source located in air at a distance of 100 g/cm^2 has been performed. The moments method code RENUPAK was used successively to produce the energy spectrum in air from the point source and the energy spectrum in concrete from the air-scattered source. Angular distribution conversion factors and data to convert to other amounts of air attenuation are given. (auth)

25617 BOLTZMANN TRANSPORT EQUATION APPLIED TO THE CALCULATION OF HEAT DEVELOPMENT IN FLAT γ-RAY SCREENS. Vito Lozupone (Universita, Rome). Ric. Sci., Rend., Ser. A (2), 6: 471-91(Dec. 1964). (In Italian)

By the general transport equation of Boltzmann the attenuation of monochromatic γ radiation in homogeneous, isotropic, purely absorbant medium, characterized by plane geometry, was studied in stationary conditions. The development of heat in the screen was determined with different angular distribution hypotheses of the incident radiation. (auth)

25618 OPTIMUM SOLAR CELL SHIELDING FOR THE ADVANCED ORBITING SOLAR OBSERVATORY. Howard Weiner (Republic Aviation Corp., Farmingdale, N. Y.). 59p. (CONF-720-23)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

An analysis of the shielding requirements for solar cells in the Advanced Orbiting Solar Observatory is presented, considering radiation effects on solar cells, solar-flare protons, and particles in the radiation belts. The combination of shielding and solar paddle area that yields the minimum weight penalty is obtained. (D.C.W.)

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

25619 (AAEC/TM-283) THE DIFFRACTION ANALYSIS OF DISLOCATION LOOPS—A LITERATURE REVIEW. J. H. Chute (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1965. 15p. Dep.(mn).

The various methods available for the determination of the nature of dislocation loops observed by transmission electron microscopy are discussed and compared. (auth)

25620 (AERE-R-4853) AN INVESTIGATION INTO THE RANGE OF DEFECT SIZES WHICH ARE DETECTABLE BY COLD NEUTRON SCATTERING MEASUREMENTS. D. G. Martin (Atomic Energy Research Establishment, Harwell (England)). Mar. 1965. 24p. Dep.; $0.70(BIS), 3s. 6d. (HMSO)

The long wavelength neutron scattering cross sections of a number of different sizes of interstitial clusters and platelets in a cubic primitive lattice up to a maximum of 343 and 361 interstitials, were calculated per cluster and platelet respectively. Calculations were restricted to clusters and platelets which approximated in shape to cubes and squares respectively, and the effects of the relaxation of the neighboring lattice were completely neglected; also, in all cases both differential cross sections as a function of scattering angle and total cross sections as a function of neutron wavelength were calculated. In order to compare the differences in the shapes of the various cross section curves as a function of aggregate size, and to decide whether such differences are significant, standard errors were introduced into the calculated results, corresponding to what are considered to be reasonable errors in hypothetical experimental measurements. Other experimental limitations are discussed and made allowance for. The results of such a comparison show that within the size range investigated all cluster sizes are distinguishable from one another by means of differential cross section measurements, but that for platelets this is only true up to 81 interstitials per platelet. Total cross section measurements can distinguish clusters up to 64 interstitials per cluster, but larger sizes can only be measured to an accuracy of about 40%. For platelets, up to 20 interstitials per platelet can be distinguished, while larger sizes can be measured with an accuracy of between 30 and 70%, this value increasing with size. (auth)

25621 (IITRI-1184-16) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 16, November 16, 1964—February 15, 1965. J. J. Markham (IIT Research Inst., Chicago, Ill.). Mar. 23, 1965. Contract AT(11-1)-587. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Previous reports have: (1) described a method for sequential saturation and observation of the EPR absorption of F-centers in KCl at 4°K; (2) presented the experimental data and derived the results to be expected using a somewhat phenomenological treatment of the absorption based on the spin packet model. Since agreement was not obtained, this report discusses modifications of the model necessary to obtain an interpretation of the experimental results. First a quantum mechanical discussion of approximate energies and transition probabilities is considered for an isolated center. This indicates that a spin packet model must be modified to include more than one type of transition. Then the kinetics of the first population distribution within the energy levels available to the system is considered. Qualitative agreement can be obtained with the observation of a wide hole and its power dependence at low temperatures. (auth)

25622 (NYO-2722-1) STATISTICAL THERMODYNAMICS OF METALLIC SOLUTIONS. Final Report, February 1, 1961—June 30, 1964. L. P. Skolnick and C. E. Birchenall (Delaware Univ., Newark. Dept. of Chemical Engineering). Contract AT(30-1)-2722. 130p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

An electronic cell model for metal solutions was developed which explains the energy of formation of alloys in terms of electron density changes and pairwise interaction changes. The application of the model to some actual binary systems is shown. Thermodynamic properties of the Cu—Au—Ag systems were studied using both the Knudsen effusion technique and electromotive force measurements, and the results are compared with the predictions of the electron cell model. The development of a method for determining the work function of alloys and unfinished studies on Cu—Au—Ag alloys are considered briefly. (D.L.C.)

25623 (TID-21682) A STUDY OF THE INTERACTION BETWEEN POINT DEFECTS AND DISLOCATIONS THROUGH DISLOCATION DAMPING EXPERIMENTS. Annual Progress Report. (Carnegie Inst. of Tech., Pittsburgh, Pa. Metals Research Lab.). Feb. 1, 1965. Contract AT(30-1)-3001. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in investigations of the statistical thermodynamics of defect interactions, dislocation damping in dilute copper alloys, diffusion-controlled dislocation damping, thermally activated dislocation depinning, ultrasonic attenuation in type II superconductors, and dislocation pinning by ultraviolet light. (W.L.G.)

25624 (UCRL-11977) DISLOCATION DYNAMICS. J. E. Dorn, J. Mitchell, and F. Hauser (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1, 1965. Contract W-7405-eng-48. 44p. (CONF-650503-2). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Experimental Stress Analysis Association, Denver.

A brief summary is presented on the current status of knowledge regarding the dynamic behavior of crystalline materials in terms of athermal, thermally activated, viscous damping, and relativistic motion of dislocations. It is shown that dislocation concepts have contributed substantially to a better and more unified rationalization of the dynamic behavior of crystalline materials than heretofore possible. Particular emphasis is given to the need for a more complete theoretical understanding of dislocation mechanics. And, the requirements for more detailed and better experiments is expressed particularly for dislocation velocity determinations in the viscous damping and relativistic ranges of conditions. (auth)

25625 (AI-Trans-84) ON THE EDDY CURRENT LAG OF MAGNETIC CONTACT PROCESSES. W. Wolman and H. Kaden. Translated by Anthony Cornell (Atomics International, Canoga Park, Calif.), from Z. Tech. Physik, 13: 330-5(1932). 13p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The formation of the magnetic flux in sheet iron after sudden switching on of the outer magnetic field is discussed. A time constant that represents a measure of the duration of the process can be specified for the case of constant permeability. A simple linear relationship exists between this time constant and the limiting frequency defined for the stationary alternating field. The exact solution can be replaced by a simple approximate solution; the latter is visualized by a magnetic equivalent circuit diagram. The case of a greatly variable permeability (steep hysteresis loop) can be treated as the penetration of a steep induction wave front from the edge into the interior of the iron. A penetration time is obtained for the sheet core that is twice the time for the wire core of the same wire diameter as the sheet thickness. (auth)

25626 (UCRL-Trans-1203(L)) THE EFFECTS OF MATRIX ANIONS ON TRAPS IN SOME MIXED-MATRIX ALKALI HALIDE PHOSPHORS. A. Kh. Khalilov and F. K. Isaev. Translated by Z. St.-Gallay (Univ. of California, Lawrence Radiation Lab., Livermore), from Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Mat. i Tekhn. Nauk, No. 4, 135-45(1963). 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI; $2.60(fs), $0.98(mf) JCL.

The effects of matrix anions on various traps in silver- and copper-activated mixed-matrix KCl + KBr phosphors are described. Series of monocrystalline phosphors of types KCl + KBr : AgCl and KCl + KBr : CuCl were prepared, in which the two-matrix components were varied, thereby effectively altering the ratio between the two matrix anions Cl^- and Br^-. The ensuing effect on the traps was investigated by noting the corresponding changes in the absorption spectra. The explanation of the phenomena found is that the activator and other capture centers are of substantial (isostructural) nature, and are adjacent to matrix anions in these mixed-matrix phosphors. (auth)

25627 ACTIVITIES OF THE LABORATORY OF SOLID STATE PHYSICS OF CISE. A. Ascoli, M. Asdente, and E. Germagnoli (Laboratori CISE, Milan). Energia Nucl. (Milan), 12: 218-29(Apr. 1965). (In Italian)

25628 ELEMENTARY EXCITATIONS IN SOLID MATERIALS. PART 2. Tore Olsen. Fra Fysik. Verden, 26: 67-70(1964). (In Norwegian)

Elementary excitations in solids are discussed from the viewpoint of plasmons, excitons, spin waves, excitations in magnetic fields, and superconductors. (J.S.R.)

25629 QUANTUM CELL MODEL. II. A CORRESPONDING-STATES APPROACH TO AN EQUATION OF STATE AT HIGH DENSITIES. Ian H. Hillier, W. Ieuan Jenkins, and John Walkley (Imperial Coll. of Science and Tech., London). J. Chem. Phys., 42: 3413-19(May 15, 1965).

The equation of state of a system of light molecules is regarded as the sum of a classical term and a quantum correction term. Experimental data for argon are used as the classical contribution and the quantum term is evaluated both for a 12-6 Lennard-Jones cell model and for a uniform potential approximation of this model. The former is seen to give a quantum correction term far too small in magnitude, while the latter approximation produces theoretical isotherms in good agreement with experimental data for both hydrogen and deuterium. Experimental hydrogen-deuterium data are then used to construct high-temperature classical corresponding-states isotherms. (auth)

25630 THE EFFECT OF ANHARMONIC VIBRATION ON THE DEBYE-WALLER FACTOR AND THE DIFFUSE SCATTERING OF X-RAYS. Yasuji Kashiwase (Nagoya Univ., Japan). J. Phys. Soc. Japan, 20: 320-35(Mar. 1965).

Contributions of anharmonic vibration to the Debye-Waller factor and the intensity of x-ray diffuse scattering were calculated for polyatomic crystal by the quantum statistics. Applying the anharmonic parameters obtained in the theory of specific heat, the contribution to the temperature factor and the intensity of diffuse scattering were estimated numerically for ionic crystals. From the comparison between the results of calculation and experiments, it was shown that most parts of anharmonic effect arise from the thermal expansion, although cubic and quartic anharmonic contributions are noticeable for KCl at high temperatures. The effect of anharmonicity was investigated at absolute zero degree in ionic crystals. (auth)

25631 ELECTRONIC STATES IN PERTURBED TWO-DIMENSIONAL GRAPHITE LATTICE. Yoshiichi Fukuda (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 20: 353-8 (Mar. 1965).

The effects on the band structure of two-dimensional graphite due to localized perturbations are studied by using a network model. The density of states near the Fermi energy is considerably modified by such perturbations. In the case of attractive perturbation, the density of states above the Fermi energy is increased and the density of states below the Fermi energy is slightly decreased. In the case of repulsive perturbation, the reverse is true. (auth)

25632 TEMPERATURE DEPENDENCE OF X-RAY ABSORPTION BY CRYSTALS. II. DIRECT PHONON ABSORPTION. Y. H. Ohtsuki (Tokyo Univ.). J. Phys. Soc. Japan, 20: 374-80(Mar. 1965).

The part of absorption coefficients of x rays arising from the phonon excitations is calculated quantum mechanically. When the polarization vectors of the incident x rays are in the diffraction plane, and are parallel to the direction of diffracted wave, the cross terms of the direct phonon and the photoelectric excitations mainly contribute to the h-wave absorption coefficient (i.e., h-component of the absorption coefficient in the two-wave approximation). It is also concluded that the direct phonon excitation could be significant near the absorption edges. (auth)

25633 EXTENSION OF THE BORN-MAYER DYNAMICAL THEORY OF IONIC CRYSTAL LATTICES AS APPLIED TO LANTHANUM TRICHLORIDE. Jack Philip Citron. Thesis, Los Angeles, Univ. of California, 1964. 106p.

Given the geometry and chemical composition of an ionic crystal, it is desired to calculate the frequencies and normal modes of vibration of this material assuming a perfect and infinite lattice. If the crystal is cubic, a point charge model in which only long-range Coulomb forces and short-range repulsive forces are admitted is known to be sufficient for establishing a dynamically stable system. Choosing a particular non-cubic substance, $LaCl_3$, the unrefined model is found to be inadequate for the attainment of dynamical stability. It is clear that such a lattice can support induced electric dipoles even in the static equilibrium configuration. A self-consistent scheme to compute these induced dipoles using Tessman, Kahn, Shockley polarizabil-

ities is shown and monopole–dipole interactions are added to the long-range forces. Details of the results of several models incorporating successively higher order approximations indicate that even an exact treatment would show this system to be unstable. The short-range forces computed to balance the long-range forces at equilibrium are assumed derivable from a two-particle potential of the Born-Mayer form, $A \exp(-r/\rho)$. A formulation is presented in which the Born-Mayer concept is extended so as to include additional short-range forces due to ionic distortions. Further, the short-range force field is considered capable of inducing such distortions along with the electric field, and their combined effects on such entities as the TKS polarizabilities and Lorentz factor are analyzed. Calculations for one more model are discussed in which the distortions produced by electronic polarization enter the short-range forces but no short-range induction of electronic distortion is included. Twenty of the twenty-one optical modes are found to be stable and there is good reason to speculate that the addition of the short-range induction mechanism could completely stabilize the crystal. The equations and plan of attack required for programming the calculations for this "complete" model are given. (Dissertation Abstr., 25: No. 6, Dec. 1964)

REACTOR TECHNOLOGY

General

25634 (HW-84369) PHYSICS RESEARCH QUARTERLY REPORT, JULY–SEPTEMBER 1964. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 15, 1964. Contract AT(45-1)-1350. 62p. Dep.; $3.00 (cy), 2(mn) CFSTI.

Nine sections are included. Separate abstracts were prepared for eight. The section for which no abstract was prepared is concerned with experiments in the Plutonium Recycle Critical Facility. (J.R.D.)

For abstracts of individual sections see: 25245, 25246, 25470, 25684, 25685, 25696, 25747, and 25759.

25635 SOME REMARKS ON THE SURFACE RESONANCE ABSORPTION IN HETEROGENEOUS REACTORS. R. Bonalumi (Laboratori CISE, Milan). Energia Nucl. (Milan), 12: 189-204(Apr. 1965).

A formulation of the surface resonance absorption in heterogeneous reactors with a 1/E spectrum in the moderator is described on the basis of a theory using a first collision probability method. Explicit formulas are proposed for cluster fuel assemblies, and are favorably compared with experiments. (auth)

25636 ACTION ON REACTOR PROJECTS UNDERGOING REGULATORY REVIEW. Nucl. Safety, 6: No. 2, 219-27(Winter 1964-65).

The ways in which engineered safeguards are being used and the criteria concerned with their use in reactor plants are discussed. A calendar of legal steps in licensing U. S. power reactors is given. A power transient at the Big Rock Point Nuclear Plant, an accident at the BONUS, license applications for CVTR and Enrico Fermi Atomic Power Station, a shutdown of the Hallam Reactor, liscense applications for gamma scan in Indian Point Reactor, analyses of the Nine Mile Point Nuclear Station and the Oyster Creek Nuclear Power Station, hazards analysis of the Peach Bottom Reactor, and specification changes for the Vallecitos Superheat Reactor are discussed. (M.C.G.)

25637 IMPROVEMENTS RELATING TO LIQUID-MODERATED NUCLEAR REACTORS. (to European Atomic Energy Community). British Patent 978,499. Dec. 23, 1964. Priority date Oct. 5, 1962, Belgium.

A method and apparatus for using a neutron flux oscillation method of operating a liquid-moderated nuclear reactor are described. The method consists of simultaneous oscillation of two elements having different neutron properties being introduced alternately into the reactor core where they replace one another. A tube is disposed on the reactor axis and contains an oscillating assembly formed by two fuel rods, one irradiated and one non-irradiated. The oscillating assembly extends through the reactor immersed in the moderator liquid contained in a pressure vessel and issues below the reactor to inside an extension of the pressure vessel extending through the bottom screening of the reactor. The extension of the pressure vessel is a tube concentric with the tube containing the oxcillating assembly and is so arranged that while the irradiated rod is inside the reactor, the non-irradiated one is completely outside the core and is not shielded; however, when the irradiated fuel rod is outside the reactor, shielding is maintained. (B.L.M.)

25638 FIRE DETECTION IN GRAPHITE MODERATED, CO_2 COOLED REACTOR. Robert D. Collins (to United Kingdom Atomic Energy Authority). U. S. Patent 3,163,580. Dec. 29, 1964. Filed Jan. 28, 1960.

A method is patented for detecting fires in reactors cooled by CO_2 normally containing varying amounts of CO. A sample representative of the normal coolant and a sample of the coolant at the outlet of the channel being monitored are compared in an infrared gas analyzer to detect CO caused by combustion. (A.G.W.)

Auxiliaries and Components

Refer also to abstracts 24686 and 24831.

25639 (GEMP-334C) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. VOLUME III. INSTRUMENTATION AND CONTROLS. Fourth Annual Report. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Feb. 26, 1965. Contract AT(40-1)-2847. 53p. Dep.; $3.00(cy), 1(mn) CFSTI.

Progress in two reactor instrumentation and control programs is reported. A complete integrated temperature-measuring system was developed for service in oxidizing atmospheres. The capacitance temperature sensor, utilizing the change in dielectric constant of the single-crystal alumina element, provides a high degree of reproducibility. Compensated a-c ionization chambers were designed and built for monitoring and controlling high-temperature, high-performance reactors. Results indicate that these chambers are best suited for power-range and upper intermediate-range operation. (W.L.G.)

25640 (IITRI-578P21-12) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, August–September 1964. E. V. Gallagher, comp. (IIT Research Inst., Chicago, Ill.). Contract AT(11-1)-578. 29p. Dep. (mn); $2.00(cy), 1(mn) CFSTI.

Several new crushable shield designs were presented to the SWIMM code to allow continuance of the debugging activities. Completion of some new runs provided insight into the problem of proper shield design. Shock tube tests on crushable solids for shock impingment studies consisted of one impact test and two reimpact tests on the same redwood specimen. Reduced data were compared to the calculated trends from static tests to determine the difference between static and dynamic behavior of redwood in loading and were used to determine the pressure-volume states of redwood in unloading. A description of the water shock tube, used for coolant decompression experiments, and its operation are given. (W.L.G.)

25641 A NEW TECHNIQUE FOR PRECIPITATION OF PRODUCTS RESULTING FROM FISSION. S. Jacobi (Kernforschungszentrums, Karlsruhe, Ger.). Atompraxis, 11: 131-4(Mar. 1965). (In German)

Various techniques for precipitating products resulting from fission in set-ups for monitoring sheath damage in fuel elements in reactors are discussed, and a new precipitator is described. It contains no moving parts, and operates with a miniature counting tube in order to avoid the gas-disturbance effect. This counting tube is not specially made, but rather an ordinary industrial product. The precipitator was tested experimentally with the arrangement for monitoring sheath damage in the reactor FR2. The first measurement results are given: they indicate the advantages of this simply constructed precipitator. (auth)

25642 DETERMINATION OF THE ECONOMICAL NUMBER OF EVAPORATORS FOR THE COOLING WATER MAKE-UP OF PRESSURIZED WATER REACTORS. W. Fratzscher and H. Stephan (Technische Universitat, Dresden). Kernenergie, 8: 162-7(Mar. 1965). (In German)

For the continuous water coolant make-up of pressurized water reactors by means of evaporator systems, a method of determining the economic number of evaporators is given for direct current circuit, which has respect to the features of continuous water make-up occurring by reason of the existence of a given temperature gradient and the necessity of holding the active wastes in storage. (auth)

25643 EFFECT OF OPERATING EXPERIENCE ON SAFETY-SYSTEM DESIGN. S. J. Ditto. Nucl. Safety, 6: No. 2, 183-4(Winter 1964-65).

Examples are given of reactor operating experiences which could have an effect on safety system design. (M.C.G.)

25644 CONCRETE CONTAINMENT STRUCTURES. R. F. Denkins and T. E. Northup. Nucl. Safety, 6: No. 2, 194-201(Winter 1964-65).

The use of concrete containment vessels where the concrete shielding of the nuclear power reactor can be used as a barrier for both radiation and pressure is discussed. Design data are given for containment structures of steel, reinforced concrete, and prestressed concrete. The ways in which reinforced and prestressed concrete are being used by designers to meet containment needs are described. The Indian Point steel sealed-envelope reinforced-concrete structure is also described. Economic factors are considered. (M.C.G.)

25645 ENGINEERED SAFEGUARDS. H. B. Piper. Nucl. Safety, 6: No. 2, 201-9(Winter 1964-65).

Techniques developed in efforts toward greater reactor safety by use of mechanical devices or other engineered safeguards are described. Means for preventing or minimizing fission-product release to the environment include: means for preventing or minimizing the melting of fuel materials, means for removing fission products from the containment system atmosphere, means for reducing internal pressure, and provision of two or more barriers around the primary system. Important factors in safeguard dependability are outlined. Core cooling systems, container cooling systems, filter systems, and multiple containment are discussed from the point of view of providing safeguards. (M.C.G.)

25646 IMPROVEMENTS IN OR RELATING TO GAS COOLED REACTORS. Samuel Brittan Hosegood, Geoffrey Winton Horsley, Cecil Harper and Bernard William Collins (to United Kingdom Atomic Energy Authority). British Patent 966,978. Aug. 19, 1964. Filed Dec. 9, 1960.

A gas-cooled nuclear reactor is patented in which the core contains the following features: a number of separate flow paths for gas, ducts communicating the flow paths with a flow restricting orifice, and means in the ducts for separating solid particles from the gas upstream of the orifice to prevent its obstruction. The orifice is preferably formed at the end of a pipe that is concentric with the axis of a cyclone separation chamber and extends from the base of the chamber so as to define an annular space within which suspended solids may accumulate. Periodic sampling of the gas is made to determine degree of contamination by fission products. A double walled pipe having an annular space between the walls that communicate the interior of the cyclone separation chamber with a sampling duct along which a sampling may be withdrawn. (B.L.M.)

25647 IMPROVEMENTS IN DEVICES FOR DETECTING FISSIONABLE MATERIAL JACKET BURSTS IN NUCLEAR REACTORS. Andre Roguin and Rene Donguy (to Commissariat a l'Energie Atomique). British Patent 967,067. Aug. 19, 1964. Priority date Nov. 13, 1959, France.

The device comprises a movable metallic drum provided with means that rotate the drum according to a predetermined program in such a manner that successive areas on the periphery of the drum are brought into a taring position opposite the detector, then into an ion collecting position opposite a repulsion electrode, and thirdly into a measuring position. The gaseous cooling stream flows through a decay and ion formation chamber having an aperture that is tightly closed by a portion of the periphery of the drum forming a collecting area. The device is completely described in British Patent No. 923,083, and the present invention relates specifically to increasing the sensitivity of the device by increasing the number of ions collected in every sector of the periphery of the drum for a given concentration of very short lived fission products in the coolant gas. The background noise is also reduced by increasing the distance between the detector and a sector of the drum in its collection position and by reducing the permanent or residual activity of the different sectors of the drum. (B.L.M.)

25648 METHODS AND DEVICES FOR HANDLING FUEL ELEMENTS IN A NUCLEAR REACTOR. Andre Gemuchian and Alain Virnot (to Societe Indatom). British Patent 967,150. Aug. 19, 1964. Priority date Mar. 23, 1962, France.

The method and device for handling fuel elements in a reactor are characterized in that the device comprises a frame lowered into one of the fuel access tubes that pass through the reactor shield and supporting a deformable system for guiding the fuel elements. The frame is supported by a cable fitted at the extremity to a handling gripper, and one portion of the frame forms a stop for the purpose of centering the device and its deformable system in collapsed position inside the frame by the tractive effort of the cable resulting from the weight of the device. The orientation of the frame is selected by inserting it in one of a plurality of angularly spaced positions. The deformable system expands outward from the collapsed position up to a predetermined radial distance as and when the stop on the frame is brought into abutment with a support surface within the reactor due to reduction in the tractive force of the cable. After servicing, the deformable system is collapsed and withdrawn through the access tube. (B.L.M.)

25649 IMPROVEMENTS IN OR RELATING TO GRABS, PRIMARILY GRABS FOR NUCLEAR REACTOR FUEL ELEMENTS. Ronald Scott Challender (to United Kingdom Atomic Energy Authority). British Patent 967,203. Aug. 19, 1964. Filed June 7, 1962.

A refueling arrangement suitable for use with graphite sheathed fuel elements is patented comprising a fuel element defining a longitudinal cavity exposing an engaging member that is secured to the base of the fuel element at the end of the cavity and a grab head that can be lowered into the cavity to engage the engaging member. The grab is made up of a grappling member, a draw bar, and fluid pressure means for effecting relative axial motion between the grappling member and the draw bar. The grappling member has a supporting member at one end and an annular series of resiliently deflectable fingers at the other end. A draw bar axially slidable within the series of fingers deflects the fingers radially outward into engagement. A ball indent device is provided for locking arrangement between the grab and the body. (B.L.M.)

25650 CONTROL DEVICE FOR A NUCLEAR REACTOR. (to General Nuclear Engineering Corp.). British Patent 967,338. Aug. 19, 1964. Priority date Dec. 2, 1960, United States.

A control device for a nuclear reactor disposed in the core includes a plurality of elongated members, each of which contains a nuclear fuel on one side and a neutron poison on the other side. Means is provided for the manipulation of at least some of the members about their longitudinal axes or about a common longitudinally extending axis between a position where the fuel is masked to a predetermined extent by poison with respect to the exterior of the device and a position where the fuel is unmasked by poison. This device provides a simple mechanical arrangement for moving the control device as well as eliminating axial flux distortions as a result of the adjustment of the control. The presence of poison within the reactor core at all times acts as a safety feature in that it reduces the possibility of an accident. (B.L.M.)

25651 CONTROL ARRANGEMENTS FOR NUCLEAR REACTORS. James Douglas Thorn, Ronald Scott Challender, and Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). British Patent 967,404. Aug. 19, 1964. Filed June 4, 1962.

A nuclear reactor is comprised of a core structure housed within a vessel and has control rods supported from below the structure and movable into a space above the structure. The vessel has branch pipes that penetrate

the shell from above the core structure for access to the structure and are closed by plug members carrying the rod guiding means, which is of extensible tubular form and is supported from the top of the core structure. (B.L.M.)

25652 IMPROVEMENTS IN AND RELATING TO ACTUATING MECHANISM FOR CONTROL RODS. Douglas Oliver Hanson (to Nuclear Power Plant Co. Ltd. and AEI-John Thompson Nuclear Energy Co. Ltd.). British Patent 967,513. Aug. 26, 1964. Filed Jan. 26, 1962.

An actuating mechanism for vertical main control rods, or additional vertical neutron absorber rods, in nuclear reactors is described that will operate from normal electrical alternating current at mains frequency. The mechanism is comprised of a rotatable member around which passes a flexible member supporting the rod. Rotation of the member causes the rod to be raised or lowered. A motor is connected to the rotatable member through reduction gearing. At least part of the gearing is housed in a casing that is free to rotate. When electromagnetic means are energized, casing is locked in position to enable the transmission of a drive through the gearing from the motor to the rotatable member. The radius of the rotatable member and the weight of the suspended parts, including the rod, are adjusted to exert a torque that is sufficient to insert the rod into the reactor under the action of its own weight when the electro-magnetic means are de-energized. (B.L.M.)

25653 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL COMPONENTS. Alan Thomas Hooper (to United Kingdom Atomic Energy Authority). British Patent 967,519. Aug. 26, 1964. Filed Aug. 16, 1962.

A core component for a nuclear reactor consisting of an annular column of spines some of which act to position fissile fuel bodies is patented. Each spine is joined by links to at least one of the adjacent spines so as to allow relative articulation between adjacent spines. The component is adapted for positioning in an annular coolant passage in the reactor core and is spaced from the coolant passage walls by projections extending from links between the spines. The annular column of spines may be mounted co-axially between an outer and an inner cylindrical wall spaced apart to define an annular flowpath for coolant fluid. The links joining the spines are so positioned to encourage the fluid passing through the flowpath to follow a helical path. (B.L.M.)

25654 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR INSTALLATIONS. (to Babcock and Wilcox Co.). British Patent 967,901. Aug. 26, 1964. Priority date Dec. 4, 1959, United States.

An installation for developing nuclear power and relating specifically to the preheating of a reactor before operation and to the cooling of the reactor after shutting down is patented. The reactor includes a vessel enclosing the reactor core with a pressure enclosure surrounding the vessel and enclosing a relatively narrow flow space encircling the vessel. During reactor operation a monitoring fluid is impelled through this flow space. During start-up and shut-down operations a heat transfer fluid flows through the flow space. Provision is made for alternatively heating and cooling the heat transfer fluid. (B.L.M.)

25655 FUEL ELEMENT LOADING AND UNLOADING APPARATUS FOR A NUCLEAR REACTOR. (to Sulzer Freres, Societe Anonyme). British Patent 968,002. Aug. 26, 1964. Priority date Dec. 21, 1960, Switzerland.

A simple and robust apparatus that includes provision for cooling the still-heat producing fuel elements removed from the reactor is described. The apparatus comprises a transporting device of the gantry type carrying a tank that accommodates an elevator mechanism having a connector for attaching it to the fuel element. The apparatus is particularly useful with nuclear reactors in which the fuel elements comprise fuel rods of fissionable material enclosed in gas-tight pressure tubes and in which loading and unloading of fuel elements is accomplished from the bottom of the reactor. (B.L.M.)

25656 IMPROVEMENTS IN OR RELATING TO SERVICING MACHINES FOR NUCLEAR REACTORS. Terence Edward Gouvenot Gardiner, Robert Garbutt, and Arthur Harry Oliver Brown (to Bristol Aerojet Ltd.). British Patent 968,091. Aug. 26, 1964. Filed Sept. 16, 1959.

An arrangement for transferring fuel rods along a path between a standpipe of a reactor and a storage magazine of a servicing machine for the reactor includes means for maintaining a flow of cooling gas past a fuel rod anywhere in the path or magazine. The servicing machine provides a duct for placing the magazine in communication with the standpipe of the reactor for transference of the fuel rods. Communication between the magazine and the duct is controlled by a valve, and a gas cooler is connected to supply cool gas to the magazine and thence along the duct. A return gas passage leads to the gas cooler and has an inlet disposed for communication with the same standpipe as the duct. A second valve opens and closes off communication between the magazine and the gas passage. The machine may also include means for supplying hot gas into a magazine for pre-heating a fuel element. (B.L.M.)

25657 IMPROVEMENTS IN OR RELATING TO LOAD GUIDING DEVICES, FOR EXAMPLE CHARGE CHUTES FOR NUCLEAR REACTORS. Terence Edward Gouvenot Gardener and Robert Garbutt (to Bristol Aerojet Ltd.). British Patent 968,092. Aug. 26, 1964. Filed Sept. 16, 1959.

A load guiding device applicable to charge chutes for changing rod type fuel elements disposed in channels in the moderator core of a reactor consists of two casing parts that are rotatable relative to one another in one direction. One of the casing parts carries a load-guiding member that is movable transversely to the axis of relative rotation of the casing parts. An actuating member of the device serves, when moved in one sense, to rotate the casing part and load-guiding member relative to the other casing part about the axis. When the actuating member is moved in the other sense, the load-guiding member is moved transversely to the axis. (B.L.M.)

25658 IMPROVEMENTS IN AND RELATING TO GRABS. Donald Mason Sutherland (to Nuclear Power Plant Co. Ltd. and AEI-John Thompson Nuclear Energy Co., Ltd.). British Patent 968,137. Aug. 26, 1964. Filed Nov. 9, 1962.

A grab suitable for lifting fuel elements from the core of a reactor and having arms adapted to engage a body to be lifted, lowered, or otherwise moved into a given position is patented. The arms are arranged in at least two groups that operate independently. Since the arms of the grab are retracted into a casing until the body to be engaged is contacted, the arms offer no impediment to placing the grab in proper position. The first part of the grab to contact the body to be engaged is a probe, and the probe moves relative to the casing with further movement of the grab and operates a release mechanism to cause the arms to engage Then the upward movement of the probe operates a further release mechanism to actuate an electrical means to lock the arms of the grab in the engaged position around the body. A safety lock mechanism is also provided to back up the electrical means for locking in case of failure of the electrical supply. (B.L.M.)

25659 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Terence Edward Gouvenot Gardiner, Robert Garbutt Peter Michael Runacres, and Michael David Champion (to Bristol Aerojet Ltd.). British Patent 976,981. Dec. 2, 1964. Filed Sept. 16, 1959.

For a reactor in which a space exists between the top of the pressurizable vessel and the moderator core a guide means is designed for guiding the control rods across the space between the standpipes and the control rod channels in the moderator core. The guiding means for each control rod comprises a guide tube for containing the control rod and a fixed guide member, which is disposed between the moderator core and the standpipe, for guiding the guide tube. The tube is axially movable through the standpipe and is of sufficient length to permit one end to be lodged

in the top of the associated control rod channel and the other end to be disposed in the standpipe. Centering means are provided for each end of the guide tube, and at all times the guide tube is supported against lateral displacement at not more than two locations. (B.L.M.)

25660 IMPROVEMENTS IN OR RELATING TO MODERATOR STRUCTURES FOR NUCLEAR REACTORS. Georges Lemesle, Roger Martin, France Marcel Monteil, and Pierre Rouge (to Commissariat a l'Energie Atomique). British Patent 977,019. Dec. 2, 1964. Priority date Mar. 11, 1960, France.

The moderator structure includes an assembly of bars of square section located one above the other to form adjacent columns, and play is provided between each column and the neighboring columns. The bars are connected by parallelepiped keys in longitudinal radial keyways formed in the lateral sides and the two opposing corners of the bars. One set of keys connects two superposed bars in one column and at least one bar in an adjacent column along each lateral face, and the second set of keys prevents opening of the pile of columns parallel to the directions of the first keys. Since the coupling with keys allows a certain amount of freedom of movement between the columns, a peripheral holding element for rigidity of the moderator is provided by a number of pillars of metallic material fixed at one point to the seat of the reactor core and at the other point to the top of the reactor. (B.L.M.)

25661 IMPROVEMENTS IN OR RELATING TO MODERATOR STRUCTURES FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). British Patent 977,020. Dec. 2, 1964. Priority date Mar. 11, 1960, France.

A moderator structure for a nuclear reactor comprises a plurality of parallel adjacent columns of moderator material and a plurality of rigid pillars forming a squirrel cage on the periphery of the pile of columns. Each pillar is coupled to the moderator columns by keys engaged in keyways in the columns and pillars. The pillars may take any of the following forms: a prismatic bar of the moderator material incorporating a post of a material of high mechanical strength, a hollow bar of moderator material with a coaxially located prestressed tie rod, or hollow prismatic bars of metallic material. Each pillar is fixed at one extremity to a seat supporting the columns of moderator material and at the other extreme to a connecting means, which is in turn connected to the outer metallic vessel of the reactor. (B.L.M.)

25662 SEALING SYSTEM FOR THE CHARGE/DISCHARGE OF A NUCLEAR REACTOR. Paul Chemin and Jean Lephilibert (to Commissariat a l'Energie Atomique). British Patent 977,293. Dec. 2, 1964. Priority date Oct. 25, 1961, France.

A sealing system between the charge/discharge machine of a nuclear reactor and a vertical loading channel which passes through the reactor cover is described in which the machine is supported by jacks that produce the vertical downward movement of the machine. The jacks that support the machine are mounted on a first trolley that is adapted to move in one direction along a track and that is in turn carried by a second trolley adapted to move in a second direction at right angles to the first. The loading channel is provided axially with an inner tube that terminates at the top end in a flange fitted with O-ring seals designed to establish fluid-tight contact with the bottom end of the machine when the machine is lowered into position. (B.L.M.)

25663 IMPROVEMENTS IN OR RELATING TO SEALED CLOSURE MEANS FOR APERTURES. Norman Thomas Barrett and Harvey Jefferson Smith (to United Kingdom Atomic Energy Authority). British Patent 977,319. Dec. 9, 1964. Filed Nov. 24, 1961.

A sealed closure means for apertures in vessels and chambers such as containment pressure vessels of nuclear reactors is described. The closure means is made up of a hinged door member, a resilient sealing means associated with the door member and the portion of the vessel or chamber that bounds the aperture, means for causing an amount of pivotal motion of the door member about its hinge just sufficient to disengage the door member from the sealing means, and means for displacing the door member in a transverse direction relative to the aperture. When the door member is in abutting sealing engagement with the vessel, three separate motions are necessary for opening the door. (B.L.M.)

25664 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Michel Cambounet, Guy Rouge, and Roger Martin (to Commissariat a l'Energie Atomique). British Patent 977,537. Dec. 9, 1964. Priority date May 27, 1960, France.

A closure for a reactor pressure vessel consists of a rigid ring having its external surface fitted against the inner surface of the aperture to be closed and a central plate or slab concentric with and adapted to rest upon the ring when the vessel is under internal pressure. This type cover can be assembled and disassembled rapidly, is simple to manufacture and handle, is of reduced bulk and weight, and provides an effective locking. The reactor can readily be charged and discharged through the channels pierced through the slab coaxially to each of the chambers in the core. The pitch of the fuel elements lattice can be varied without incurring considerable cost for the cover since only the slab needs to be changed. (B.L.M.)

25665 IMPROVEMENTS RELATING TO NUCLEAR REACTORS AND A METHOD OF CONTROLLING THE REACTIVITY OF NUCLEAR REACTORS. (to Babcock and Wilcox, Ltd.). British Patent 978,016. Dec. 16, 1964. Priority date Apr. 7, 1960, Germany.

A closed tube containing solid or liquid material of high microscopic thermal neutron absorption cross section (material of cross section of 380 b or more) is positioned in the reactor core and is heated in accordance with the temperature of the core to vary the vapor density of the material within the tube to control the reactivity of the core to maintain the temperature of the core at a predetermined operating temperature. The closed tube includes a relatively thick-walled portion, which contains the solid or liquid material and in which means are provided to assist heat transfer from the coolant to the material, and a thin-walled portion lined with ceramic. The closed tube is enclosed in a graphite sleeve provided with ducts arranged to direct coolant flowing through the core over a part of the closed tube containing the solid or liquid material. (B.L.M.)

25666 SOLID MODERATOR STACK FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). British Patent 978,159. Dec. 16, 1964. Priority date July 4, 1960, France.

A solid moderator stack comprising prismatic columns disposed side-by-side in a regular lattice is described. Each column is made up by superposing tubular elements of polygonal external outline, and each element is produced by assemblying indentical prisms of BeO in each of which one of the longitudinal faces forms part of the internal wall of the duct that passes axially through the columns. The columns are connected by keys oriented parallel to at least three directions passing through the axes of the columns and engaged in longitudinal grooves machined in the lateral faces of the columns. (B.L.M.)

25667 IMPROVEMENTS IN OR RELATING TO MEANS FOR SUPPORTING NUCLEAR FUEL COMPONENTS. Alan Thomas Hooper and Albert George Montgomery (to United Kingdom Atomic Energy Authority). British Patent 978,220. Dec. 16, 1964. Filed Feb. 15, 1962.

A support means is provided for supporting a plurality of fuel elements in superposition within the coolant channels of a reactor. The support means engage the walls of the channel and castellated guide means disposed adjacent to the terminal portions of the elements are arranged to allow relative displacement of the elements in a direction longitudinally of the channel. Restricted displacement of the components relative to one another and the channel wall in a direction transverse to the channel axis may also be

provided by the guide means. The guide means may be formed by the inter-engagement of adjacent castellated end faces at the free ends of the elongated fuel components. (B.L.M.)

25668 IMPROVEMENTS IN PRESSURE-FLUID COOLED NUCLEAR REACTORS. (to European Atomic Energy Community). British Patent 978,375. Dec. 23, 1964. Priority date Mar. 1, 1962, France.

Means are provided to inhibit the movement of the nuclear fuel elements with the flow of pressure-fluid circulating through the fuel element channels of a nuclear reactor yet not substantially to interfere with movement of the elements when desired. The upwardly extending fuel element channel is connected at lower and upper positions respectively to entry and exit conduits of a coolant fluid circuit. The direction of flow is upwards in the channel, and a free plug or piston is located in the channel above the exit conduit to prevent upward movement of the element, while stop means limit the downward movement of the plug. A fluid pressure balancing connection is provided between the underside of the fuel element and the upper side of the plug. Special details of the plug design and flow details for the coolant fluid also are described. (B.L.M.)

25669 BRAKING DEVICE FOR FALLING OBJECTS. (to Groupement Atomique Alsacienne Atlantique). British Patent 978,443. Dec. 23, 1964. Priority date May 5, 1961, France.

A braking device is patented that is particularly applicable to braking and limiting the fall of control rods in nuclear reactors. The device includes a cylindrical sleeve element of readily deformable material into which is inserted by deformation of the sleeve a cylindrical element forming a stamping punch. The outside diameter of the punch is greater than the inside diameter of the sleeve. One of the two elements is fixed, and the other is movable in response to the dropping of an object whereby the deformation of the sleeve absorbs the kinetic energy of the falling object. The stamping punch can be constructed either directly on the object or separately from it and is provided with a chamber for facilitating its entrance into the sleeve. At its upper part the sleeve has a flare for facilitating the entrance of the punch. (B.L.M.)

25670 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR REFUELLING APPARATUS. James Carrie Guild (to United Kingdom Atomic Energy Authority). British Patent 978,644. Dec. 23, 1964. Filed Dec. 19, 1962.

A reactor refuelling apparatus consists of a reactor stand-pipe extending upward from the reactor core and a refuelling machine having a tubular coupling part sealable with the upper end of the stand-pipe. The machine is characterized in that the stand-pipe is provided with a trough encircling the upper end and arranged to locate the coupling part of the refuelling machine. The coupling part is movable vertically relative to the main body part of the machine by fluid pressure means in the form of a pair of pneumatic jacks. A mass of metal such as Al is disposed in the trough at the upper end of the stand-pipe and means are provided for changing the metal from a liquid to a solid and vice versa in order that a "dip" seal may be formed between the coupling part and the stand-pipe. (B.L.M.)

25671 DEFORMABLE FLUID TIGHT CONTROL CONNECTION BETWEEN TWO NUCLEAR REACTOR ENCLOSURES. Didier Costes and Jean-Claude Jacquin (to Commissariat a l'Energie Atomique). Canadian Patent 706,990. Mar. 30, 1965. Priority date Apr. 10, 1961, France.

The tubes enclosing the control rods between the concrete biological shield and the reactor vessel below, are made of thin material subject to moderate deformation without rupture. Such deformation allows creep and movements caused by thermal stress to occur without damage. Provision is made for fluid-tight seals at the reactor vessel and straight channels are avoided so that radiation cannot reach operating personnel. Easy dismantling of the control rod unit is claimed. (F.S.A.)

25672 COOLING SYSTEM FOR A NUCLEAR REACTOR. Leo Acklin (to Sulzer Freres, S. A.). U. S. Patent 3,153,618. Oct. 20, 1964. Priority date Mar. 3, 1960, Switzerland.

A cooling system for a nuclear reactor is patented wherein a heat carrier describing a primary circuit surrenders heat received from the nuclear reactor in a heat exchanger to a medium describing a secondary circuit including a heat consumer. Steam is used as the operating medium in the primary circuit, is superheated in the reactor, and flows in the form of water in part of the secondary circuit and as steam in part of the secondary circuit. Some advantages according to the invention are: steam has a greater specific heat than the inert gases usually used as operating media, steam is cheaper than the inert gases and small leakage losses can be tolerated, and since the same fluid is used in the two circuits fluid can be fed into the primary circuit from the secondary circuit. (B.L.M.)

25673 APPARATUS FOR TRIMMING THE POSITION OF A CONTROL ROD. Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). U. S. Patent 3,163,581. Dec. 29, 1964. Priority date Nov. 9, 1959, Great Britain.

An automatic control system for a gas-cooled nuclear reactor employs an electro-mechanical phase advance system that can operate at low frequencies. The output from a temperature-measuring device attached to a fuel element is compared with a reference quantity derived from a potentiometer. The difference is fed to a control rod motor, which moves the control rod in a direction to reduce the difference. The difference is also used as a resetting signal. (A.G.W.)

25674 FUEL HANDLING MACHINERY FOR A NUCLEAR REACTOR. Peter J. Collins and Ronald M. Campbell (to Canadian Westinghouse Co., Ltd.). U. S. Patent 3,163,582. Dec. 29, 1964. Priority date Aug. 30, 1958, Canada.

A heterogeneous pressurized water reactor is described in which the large, thick-walled pressure vessel of a typical pressurized water reactor is replaced by a series of individual pressure tubes maintained in a closely spaced array and each containing fissile material. The individual pressure tubes are insulated by a baffling arrangement so that the walls of the tubes and the moderator outside are maintained at a lower temperature. Coolant flow regulation for each individual tube is provided. A fuel loading and recycling system is integrated with the reactor for the purpose of loading and unloading during operation of the reactor. The pressure tubes are arranged horizontally with a shielded fueling pit at each end of the tubes, and a cross-feed fueling principle is employed. (A.G.W.)

25675 FUEL FOLLOWER FOR A HETEROGENEOUS NUCLEAR REACTOR. Thomas F. Widmer and Edward Paxson (to Westinghouse Electric Corp.). U. S. Patent 3,163,583. Dec. 29, 1964. Filed Sept. 6, 1960.

A follower device for movable reactor control rods is intended to occupy the space vacated by the rods and reduce the perturbations or peaking of neutron flux ordinarily associated with withdrawal of the rods. The device consists of an assembly of fuel rods whose lateral contours conform substantially to those of the control rod. The fuel elements are supported relative to each other and to the control rod by resilient elongated straps. Means are provided to prevent jamming of the follower against adjacent structures. (A.G.W.)

25676 SUPPORT HOUSING FOR EXTERNALLY SUPPORTING FUEL ELEMENTS. Roland Roche and Bernard Vrillon (to Commissariat a l'Energie Atomique). U. S. Patent 3,163,584. Dec. 29, 1964. Priority date May 16, 1959, France.

A support for nuclear fuel rods in a heterogeneous reactor is in the form of a cylindrical block made of material absorbing little of the neutron flux. The block contains a plurality of compartments distributed regularly around its axis and parallel to the axis. The cross-sectional area of each compartment is greater than that of the associated fuel rod to allow a passage for cooling fluid, and

each rod may be centered in its compartment by fins on the rod. The rods are held in the compartments by detachable abutments at each end of the block, and means are provided for centering each supporting structure with respect to adjacent supporting structures in the reactor duct. (A.G.W.)

25677 FUEL ELEMENT SUPPORT STRUCTURE AND LATCHING MECHANISM. George Ralph Anthony Metcalfe and Harold Alan Brown (to United Kingdom Atomic Energy Authority). U. S. Patent 3,163,585. Dec. 29, 1964. Priority date Aug. 11, 1960, Great Britain.

An apparatus for releasably suspending a nuclear fuel element from a support structure disposed above a reactor core is patented. A body part carried by the upper end of the fuel element includes a latch member, a latch-actuating member for moving the latch member into engaging and disengaging positions with the support structure, and means for retaining the latch actuating-member in the engaged position. The arrangement is particularly suitable for the reactor of a nuclear-powered ship; should the ship capsize, the fuel elements would remain in the core. (A.G.W.)

25678 REEL TYPE CONTROL ROD BRAKE. Pierre Girard (to Commissariat a l'Energie Atomique). U. S. Patent 3,164,526. Jan. 5, 1965. Priority date Dec. 6, 1960, France.

A device for the transmission of kinetic energy at the time of instantaneous stopping of a body in movement is applied to the stoppage of the safety rods of a reactor. A flexible tie is wound upon and secured at one end to a drum rigidly fixed to a rotary shaft. The other end of the tie is secured to a body vertically movable between raised and lowered positions. The drum rotates in one direction when the body is lowered. An inertia flywheel is connected to the drum in such a manner that when the body reaches its lowered position and the drum reaches its limit of rotation, the kinetic energy of the descending body is wholly and nonreversibly transmitted to the flywheel. (A.G.W.)

25679 FUEL ELEMENTS FOR NUCLEAR REACTORS. Peter Waine and James Duncan Waters (to United Kingdom Atomic Energy Authority). U. S. Patent 3,164,529. Jan. 5, 1965. Priority date May 24, 1961, Great Britain.

A cluster fuel element in which the individual fuel members of the element are spaced apart at their ends by grid support structures is designed to resist dishing stresses with only a small increase in neutron-absorbing material and pressure drop. The relatively large number of relatively thin webs that makes up at least one of the support structures is reinforced by a relatively small number of relatively thick webs. (A.G.W.)

25680 NUCLEAR REACTOR CORE WITH FUEL LOCKING MEMBERS. Othniel Neil Banks (to United Kingdom Atomic Energy Authority). U. S. Patent 3,164,530. Jan. 5, 1965. Priority date Sept. 5, 1960, Great Britain.

A nuclear reactor core structure having fuel assemblies consisting of spaced clusters of nuclear fuel elements housed in tubular coolant-conducting containers is provided with latching members for releasably retaining the fuel elements in the containers and latching members for releasably retaining the containers in the reactor core structure. The arrangement permits shuffling of the fuel elements to even out burnup and re-use of the containers. It also enables fuel elements to resist disturbing movements due to coolant pressure changes or other causes. (A.G.W.)

25681 LOCKING STRUCTURES. Didier Costes (to Commissariat a l'Energie Atomique, Paris). U. S. Patent 3,165,349. Jan. 12, 1965. Priority date Aug. 16, 1961, France.

A means for the temporary fixing of elements capable of sliding in the channels of nuclear reactors is intended for use in the loading and unloading of nuclear fuel elements during operation of the reactor. The means involves resilient tongues anchored at one end on the periphery of the element to be fixed, grooves to receive the tongues, and a control member capable of movement along the axis of the element. The tongues are urged into the grooves by their inherent elasticity and displaced from the grooves by action of the control member. (A.G.W.)

25682 STEAM COOLED NUCLEAR REACTOR. Norman Bradley (to United Kingdom Atomic Energy Authority). U. S. Patent 3,165,449. Jan. 12, 1965. Priority date June 10, 1959, Great Britain.

A pressure tube arrangement is patented for a reactor having a liquid moderator. Each pressure tube has a thin baffle member defining an inner major flow channel containing fuel elements and an annular minor flow channel between the baffle member and the inner wall of the tubes. Such an arrangement provides heat transfer to the moderator and also provides protection against bursting of the pressure tube. (A.G.W.)

25683 NEUTRONIC REACTOR INCLUDING MEANS FOR UNLOADING AND HERMETICALLY ENCLOSING SPENT FUEL ELEMENTS. Peter Fortescue and David Nicoll (to U. S. Atomic Energy Commission). U. S. Patent 3,180,800. Apr. 27, 1965.

A system was developed for removing and packaging spent fuel elements from a nuclear reactor. A fuel element transfer means is employed in which a transfer coffin disposed below the core receives the spent element and in which a tubular canister is disposed to receive same. A crimping means is provided for crimping covers on the canister and the coffin is movable to dispose the canned spent element in a storage facility. (AEC)

Criticality Studies

See *also* PHYSICS — Criticality Studies.

Refer also to abstract 25053.

25684 (HW-84369(p.5-9)) A COMPARATIVE STUDY OF UNIT CELL HOMOGENIZATION FOR $PuO_2-UO_2-H_2O$ LATTICES. R. C. Liikala (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results of a comparison of space-energy separable cell model values with those obtained in THERMOS calculations are presented for a series of Pu-fueled light water-moderated lattices. (J.R.D.)

25685 (HW-84369(p.25-33)) U–Al–POLYETHYLENE EXPERIMENT IN THE PCTR. D. G. Albertson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The first of a series of experiments which simulate homogeneous, light-water-moderated U and Pu systems was completed in the PCTR. The principal components for the experiment were U–Al (33 wt % U, enriched to 93.0 wt % ^{235}U), pure polyethylene, and borated polyethylene (0.8 wt % B). A determination was made of the B concentration necessary to reduce the value of the infinite multiplication factor (k_∞) to unity. The atomic ratio of H to ^{235}U was 214; the critical value of the atomic ratio of ^{10}B to ^{235}U was determined to be 0.119. (auth)

25686 (NAA-SR-Memo-9977) CRITICAL EXPERIMENTS WITH DRIVEN UC FUEL IN A GRAPHITE MODERATED ASSEMBLY. D. W. Latham (Atomics International, Canoga Park, Calif.). Sept. 28, 1964. Contract [AT(11-1)-Gen-8]. 86p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Critical experiments were performed with graphite moderated two-region cores consisting of a central test region fueled with 24 uranium carbide elements and a driver region fueled with uranium metal elements. The uranium carbide elements consisted of eighteen fuel pins within a stainless steel process tube with sodium filling the interstices to mock-up the coolant. Three triangular lattice pitches were studied. Within each lattice pitch, variations in proposed control channel materials and locations were studied. Results are given for two-region critical masses,

values of k_{eff} for subcritical loadings of the 24 uranium carbide fuel elements, and first ring and peripheral driver element worths. Methods and results are presented in detail in an effort to implement the analytical techniques used in design calculations for advanced sodium graphite reactor cores. (auth)

25687 (ORNL-3731(p.239-51)) PERFORMANCE ANALYSES. A. M. Perry and W. B. Cottrell (Oak Ridge National Lab., Tenn.).

A general description of reactor transients was used to develop an exact theory of the source-jerk experiment. The large space-dependent corrections ordinarily encountered in this experiment were eliminated by expressing the reactivity in terms of the ratio of certain volume integrals to be determined experimentally. Calculations show that this ratio may be obtained accurately with the use of a reasonably small number of detectors. Previous analyses of the cooling required in the EGCR in the event of the maximum credible accident are being extended to review the case of one or both main compressors operating with air as the coolant. Based on a realistic initial temperature distribution, it was found that 50,000 lb/hr core air flow starting 1 hr after scram would prevent runaway oxidation. The effect of increased air concentration in the N_2 purge system of the emergency cooling loop is also being investigated. (auth)

25688 (ORNL-TM-1066) MEASUREMENT OF REACTOR FLUCTUATION SPECTRA AND SUBCRITICAL REACTIVITY (thesis). C. W. Ricker, S. H. Hanauer, and E. R. Mann (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 105p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Submitted by C. W. Ricker to Univ. of Michigan, Ann Arbor.

Power spectra associated with the fluctuating current from a neutron-sensitive ionization chamber have been determined with precision. The neutron chamber was located adjacent to a cold clean Bulk Shielding Reactor core. The statistical characteristics of the chamber current are considered as representative of the statistical properties and therefore the dynamical parameters of the reactor. Measurements were made for various degrees of subcriticality as established by fully inserting or withdrawing one or more of three control rods. The reactivity for each subcritical condition was inferred from least squares fitting of the measured spectra to a theoretical model. The measured spectra have the form predicted by theory. The reactivities inferred from these spectra are consistent with pulsed-neutron measurements. The effect of chamber location appears to be unimportant for the reactor used in this investigation. (auth)

25689 (UCRL-13137) TEST REPORT FOR PROMPT BURST CRITICAL ASSEMBLY MACHINE "SUPER KUKLA." (Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. Industrial Equipment Div.). Oct. 9, 1964. Contract [W-7405-eng-48]. 306p. $7.00(CFSTD.

A brief description of the Super Kukla assembly is presented. Tests to determine the repeatability of a position with respect to the voltage readout on the control panel and to determine if permanent deformation sets in the cross beam of the bridge handling rig at the center of the span when a 50% overload is present are discussed. The handling device for center stack-load test, the handling device for upper uranium cylinder, test of scram valves, test lower uranium cylinder scram, test burst rod system, and strain gage grouping and method of readout of strain gages are described. (C.E.S.)

25690 NON-LINEAR PROBLEMS IN THE THEORY OF NUCLEAR REACTORS. O. B. Moskalev and V. A. Chuyanov. At. Energ. (USSR), 18: 254-5(Mar. 1965). (In Russian)

An attempt was made to find a unique positive nontrivial solution for the nonlinear integral Peierls equation $\lambda\phi(p) = A\phi$ (where A is a nonlinear operator which is assumed to be monotonous). The equation was resolved by a method of consequent approximations. Under certain conditions the resolution is unique. Thus, when the neutron angular distribution is close to isotropic, the assumption based on a diffusion approximation is fulfilled. The unique solution is possible with monotonous variation of the multiplication coefficient as a function of the neutron flux ϕ which determines the cross sections of neutron reaction with the substance. The problem was generalized for the case of multiple-speed isotropic scattering. (R.V.J.)

25691 THE CONCEPT OF REACTOR DYNAMICS EQUATION THROUGH AN INVERSE PERIOD. N. G. Chelintsev. At. Energ. (USSR), 18: 292-4(Mar. 1965). (In Russian)

The well known reactor dynamics equations are simplified by introducing the reactor inverse period term dn/ndt. Two simple examples are treated considering the formula of inverse hours developed under the condition that $(d/dt)(C_l/n) = 0$: $a = (e - \beta/l) + (1/l)\sum_{i=1}^{6}(\beta_i\lambda_i/a + \lambda_i)$, and the case in which at any reactivity variation $\rho = \rho(t)$ the magnitude of the reactor inverse period is found with $S = 0$ by assuming that $l = 0$ and by replacing the six groups of delayed neutrons by one group. (R.V.J.)

25692 ON COLLISION PROBABILITIES IN FINITE SLAB LATTICES. K. Meyer (VEB Atomkraftwerk, Berlin). Kernenergie, 8: 85-7(Feb. 1965). (In German)

An approximation of the collision probabilities is given for slabs of finite thickness having two components. The results allow separation of the equations for the neutron flux and the neutron leakage to be taken into account. As they show, the influence of neutron leakage on neutron spectrum hardening in the WWR-S reactor is noticeable. (auth)

25693 INVESTIGATIONS OF EPITHERMAL NEUTRON SPECTRA BY MEANS OF THIN RESONANCE FOILS. P. Schumann and D. Albert (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 88-92(Feb. 1965). (In German)

Using the resonance detectors ^{115}In, Au, ^{152}Sm, ^{186}W, La, Mn, and ^{98}Mo epithermal neutron spectra were studied at various points of the RFR core and in the vertical channel 2 of the RFR thermal column in the energy range 1 to 500 ev with respect to their deviations from 1/E behavior according to $\Phi(E) \sim 1/E^{\alpha}$. In an air-filled channel at the periphery of the core, $\alpha = 0.98 \pm 0.02$ was found by an absolute determination. The other measurements have been referred to this value. In the vertical channel 2 of the RFR thermal column (distance from the core boundary 60 cm), $\alpha = 1.04 \pm 0.02$. (auth)

25694 SIGNIFICANCE OF SUBCRITICALITY MEASUREMENTS BY ANALYSIS OF NEUTRON-DENSITY FLUCTUATIONS. C. W. Ricker. Nucl. Safety, 6: No. 2, 184-5(Winter 1964-65).

The method of obtaining information concerning the degree of subcriticality of a subcritical system by analyzing the neutron density fluctuations of such systems is discussed. Advantages of fluctuation analysis over other methods of measuring the reactivity of subcritical systems are considered. Experimental results of fluctuation analysis of subcritical systems were not, in general, precise enough for a critical evaluation of the validity of the mathematical models used. The influence and contribution of the neutron source in the interpretation of fluctuation measurements are discussed. (M.C.G.)

25695 THERMAL UTILIZATION AND RESONANCE INTEGRALS IN HETEROGENEOUS REACTORS. Muhammad Abdul Mannan. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 140p.

The objective of the research described was to develop a mathematical technique for solving the age-diffusion equation in "mixed" geometries in order that the resonance interference and the effect of cell approximation on thermal utilization can be investigated rigorously. In order to solve the age diffusion equation the flux is expanded in terms of the eigenfunctions of the Helm-holtz operator with energy-dependent coefficients. A determinantal equa-

tion is obtained to find the expansion coefficients. Thermal utilization is calculated assuming no slowing down, putting lethargy u = 0, and assuming a constant source of thermal neutron in the moderator. In order to find the interference between two closely spaced resonances, the higher energy resonance is replaced by a delta function sink and the spatially and energy dependent flux above the lower energy resonance is obtained by solving the age-diffusion equation. The first-collision probabilities are calculated for this flux (in the case of a slab lattice only). The resonance integrals of the lower energy resonance are calculated both in the presence and in the absence of an interfering resonance. The interference between several selected pairs of resonances is calculated for several ^{238}U and ^{232}Th lattices with graphite or heavy water as moderators. It was found that the interference between closely spaced resonances depends upon the size of the cell and it increases with the increase of the fuel lump size. The ratio of the interfered resonance integral to the uninterfered resonance integral is greater than unity in the case of the graphite-moderated lattices but the ratio is less than unity in the case of heavy water-moderated lattices. In the case of the thermal utilization calculation, it was found that the usual "equivalent cell" approximation is quite satisfactory. In the calculation of resonance escape probability, corrections should be made for the closely spaced resonances. In the case of mixed absorbers the corrections may be important. (Dissertation Abstr., 25: No. 6, Dec. 1964)

Design and Feasibility

25696 (HW-84369(p.11-19)) TRANSMUTATION LOGIC FOR S_n TRANSPORT ANALYSIS. B. H. Duane (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The machine analysis of high-exposure spectral-shift breeder reactors was extended to span bilinearly coupled multi-energy neutron transport theory and nuclide transmutation theory. Scaled-matrix power series evaluation of the matrix-exponential fine structure of the transmutation fields proves to be superior to both chain-tracing and matrix-diagonalization methods, in range, reliability, speed, and simplicity of logic relevant to the occurrence of complex eigenvalues and coalescent eigenvalues. (auth)

25697 A HETEROGENEOUS NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). British Patent 976,802. Dec. 2, 1964. Priority date Feb. 4, 1960, Germany.

A heterogeneous nuclear reactor is described in which the volumetric proportion of moderator to U in certain zones in the reactor core is increased in comparison with an average value. These zones are associated with neutron absorbers for the purpose of equalizing the neutron flux, and the absorbers are accommodated in these zones in the form of separate bodies that represent practically "black bodies" as regards neutron capture, i.e., a body consisting of a material that has a high neutron absorbing property. The black bodies may be in the form of cylinders or spheres, and their dimensions are so chosen that the desired neutron flux equilization is just obtained to eliminate overload points during the time the reactor fuel is in use. (B.L.M.)

25698 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 978,176. Dec. 16, 1964. Priority date Aug. 2, 1961, United States.

A gas cooled reactor operable at a temperature of 1200°C or above is comprised. The reactor comprises a reactive core containing fissionable material intimately mixed with a moderator and a neutron absorbing material compatible with other components of the reactor and chemically stable at temperatures of 1200°C for controlling the reactivity of the reactor. The neutron absorbing material, selected from the group consisting of Pu-240, Rh-103, Eu-167 and mixtures thereof, has a positive or negligible utilization coefficient at temperatures below 1200°C, has thermal resonance bands above 1200°C, and is present in such quantities that it provides a large negative contribution to the temperature coefficient of reactivity at temperature in excess of 1200°C and controls the excessive reactivity of the reactor. (B.L.M.)

25699 METHOD OF OPERATING BOILING COOLANT REACTOR WITH POSITIVE REACTIVITY COEFFICIENT. Joseph A. De Felice (to United Nuclear Corp.). U. S. Patent 3,153,617. Oct. 20, 1964. Filed June 16, 1960.

A method is reported for operating a boiling reactor having a mass of fissionable fuel material and a plurality of coolant channels arranged in the mass of fissionable material and in good heat transfer relation to it. A fluid coolant that exists in both the liquid and vapor phase when the reactor is in operation is contained in the coolant channels. A body of neutron slowing-down substance substantially surrounds the mass of fuel and coolant channels, and the moderating ratio of the slowing-down material is greater than that of the coolant. The method of operating the reactor comprises the steps: (1) maintaining the proportions of fissionable material, neutron slowing-down material, and the coolant such that the maximum excess reactivity of the reactor is less than one dollar during operation when the average density of the coolant is at a minimum, (2) adjusting the coolant in the channels to maintain the weight of the coolant at any time in excess of at least 0.002 times the weight of the neutron slowing-down material, and (3) carying the pressure of the coolant within the channels in accordance with the power demand. (B.L.M.)

25700 PROCESS OF NUCLEAR FISSION. Jan J. Went (to Stichting voor Fundamenteel Onderzoek der Materie). U. S. Patent 3,159,548. Dec. 1, 1964. Filed Sept. 26, 1955.

A process is described for establishing a self-sustaining fission reaction in a system comprising a nuclear fuel suspension of solid fissile material particles in a carrier liquid of low neutron capture cross section. All the suspended particles have a minimum diameter of >0.01 μ and a maximum diameter of <15 μ. In the system the continuous removal of fission products is effected by separating part of the carrier liquid from the nuclear fuel suspension circulating through the external piping system, purifying the carrier liquid, and resupplying the purified carrier liquid to the circulating suspension before its re-entrance into the reactor. (B.L.M.)

25701 NUCLEAR REACTORS. Richard Valentine Moore and Stanley Hackney (to United Kingdom Atomic Energy Authority). U. S. Patent 3,159,549. Dec. 1, 1964. Filed Mar. 10, 1959.

A reactor containment vessel having an access opening and a reactor core unit of solid form such as graphite disposed within the vessel during operation of the reactor and removable as a whole through the access opening is patented. The reactor core is disposed between a pair of shielding means to form a unit, and means are provided for securing the unit to the vessel on the side of one of the shielding means remote from the core. The shielding means provides radiation protection during removal of the core from the vessel. (B.L.M.)

Fuels

25702 (ANL-6845) STUDIES OF FAST REACTOR FUEL ELEMENT BEHAVIOR UNDER TRANSIENT HEATING TO FAILURE. II. INPILE EXPERIMENTS ON UO_2 SAMPLES IN THE ABSENCE OF COOLANT. C. E. Dickerman, L. E. Robinson, E. S. Sowa, and S. B. Skladzien (Argonne National Lab., Ill.). Jan. 1965. Contract W-31-eng-38. 47p. Dep.; $3.00(CFSTI).

In-pile experiments in the TREAT reactor were carried out on pseudo-EBR-II UO_2 clad elements which were thermally bonded to cladding with inert gas. The elements were exposed to transient power bursts (~0.5 sec) in the absence of coolant; heating rates up to 4000°C/sec were

produced. The results were compared with temperature and failure calculations. Failures were nonviolent. The stainless steel- and tantalum-clad elements failed near the temperatures predicted for clad failure, while most of the niobium-clad elements attained temperatures 200–300°C above predictions. Recrystallized granular structure began to appear for maximum central-fuel temperatures ≥2200°C, but radial cracks do not appear at the oxide surface. Higher-temperature exposures caused the oxide cylinders to break into shorter axial lengths. (D.L.C.)

25703 (HW-63084-RD) UNIRRADIATED FUEL ELEMENT MELTDOWN IN ZIRCALOY TUBE. R. K. Hilliard, H. G. Rieck, and A. J. Scott (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 1, 1960. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An experiment was performed in which a standard 4-inch solid aluminum-clad fuel element was melted while resting horizontally on a 12-inch long half section of Zircaloy process tube. The meltdown was successfully accomplished with equipment designed for this purpose. A color movie, HW-63257, was made during the meltdown sequence. A metallographic examination of the residue was performed. (D.L.C.)

25704 (HW-76195) PLUTONIUM AND U233 VALUES COMPUTED FOR SUCCESSIVE RECYCLE IN FIVE SIMULATED REACTOR TYPES. D. E. Deonigi, M. F. Kanninen, and A. F. McConiga (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 2, 1963. Contract AT(45-1)-1350. 491p. Dep.(mn); $7.91(cy), 15(mn) CFSTI.

The values of plutonium and ^{233}U in five simulated reactor types were calculated by the successive recycle or PUVE method. Four basic fueling modes were considered for each of the five reactor types—where practical—for a standard economic environment. Additional computations wherein a physical or an economic parameter was varied are included. The burn-up, the economics, and the value calculations for each of the thirty-four cases in the study are summarized. (auth)

25705 (LA-DC-6669) LOS ALAMOS MOLTEN PLUTONIUM PROGRAM. D. B. Hall (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 3p. (CONF-650417-1). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From American Nuclear Society, National Topical Meeting on Fast Reactor Technology, Detroit.

The properties and potentials of a molten Pu alloy for commercial fast breeder power applications are investigated. The operation of a 1-Mw reactor; studies of the Pu–Fe eutectic alloy (m.p. 411°C); and studies of Pu–Co–Fe alloys at various compositions are reported. Estimated performance figures, subject to experimental verification, promise economical utilization of plutonium resources. (auth)

25706 (ORNL-TM-1115) REFABRICATION TECHNOLOGY AND COSTS FOR HIGH-TEMPERATURE GAS-COOLED REACTOR FUELS. A. L. Lotts, D. A. Douglas, Jr., and R. L. Pilloton (Oak Ridge National Lab., Tenn.). May 1965. Contract W-7405-eng-26. 49p. (CONF-650606-4). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

High-temperature gas-cooled reactors utilizing the thorium–uranium-233 cycle have the potential of achieving low power costs and high fuel utilization. However, the realization of this potential depends on the development of technology for the economical refabrication of the fuel of these reactors. A description is given of the findings of an investigation of this problem. A brief description of typical nuclear fuels for HTGR reactors is followed by a discussion of the many problems concerning the refabrication of a hypothetical fuel element. Alternate fabrication flowsheets are shown, and data are presented which describe the effect of the amount of radioactive material in the fuel on fabrication plant design. Fuel refabrication costs are also discussed. The effect of ^{232}U concentration, mode of fabrication, amortization rate, plant capacity, and alternative fuel designs are represented by tables and curves. Finally, the fuel refabrication program of ORNL is described. This includes a description of the ORNL Thorium–Uranium Recycle Facility (TURF) and the plans for equipment which is to be used in the facility for demonstration of refabrication technology. The investigation indicates that several refabrication process improvements are in sight at ORNL and that the cost penalties associated with refabrication of HTGR fuels are not prohibitive. (auth)

25707 (ORNL-TM-1123) FABRICATION VARIABLES, PERFORMANCE, AND COST CONSIDERATIONS FOR HTGR COATED-PARTICLE FUELS. W. O. Harms and D. B. Trauger (Oak Ridge National Lab., Tenn.). Apr. 30, 1965. Contract W-7405-eng-26. 31p. (CONF-650606-5). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

Studies involving the development of pyrolytic-carbon-coated uranium–thorium carbide particles and of graphite-matrix fuels containing coated particles have produced a basis for HTGR fuel element designs and for fuel-cycle cost analysis. Irradiation tests combined with thermal and mechanical test evaluations have demonstrated satisfactory fuel element performance for pebble-bed reactor application. More recent work on particle coating and evaluation techniques has led to means for improved control of production variables. Pyrolytic-carbon-coated oxide fuel particles offer promise for reduced costs and satisfactory reactor service. The results presented are generally applicable to prismatic fuel structures as well as to spheres. (auth)

25708 (TRG-Report-848) DEMON: A COMPUTER PROGRAM WHICH SOLVES CERTAIN TIME-DEPENDENT EQUATIONS DESCRIBING THE DIFFUSION OF HEAT WITHIN A NUCLEAR REACTOR. C. W. J. McCallien (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Nov. 2, 1964. 34p. Dep.; $1.00(BIS), 5s. (HMSO).

DEMON is a Fortran II program for the IBM 7090 computer. It is designed to study the temperatures which would occur in a magnox reactor, such as those at Calder Hall, if the magnox in one of the fuel channels were to ignite as the result of a fault condition and were to burn in the carbon dioxide coolant. A three-dimensional model of several adjacent square cells in the reactor core is built up in the computer. The transfer of heat in the vertical direction by the coolant and the horizontal diffusion of heat are both considered. The release of Wigner energy as the moderator temperature rises is taken into account. The equations solved are stated, the method of solution by finite differences is discussed, and the data requirements of the program are given. (auth)

25709 (TRG-Report-863) FURTHER ELASTIC SOLUTIONS TO THE PROBLEM OF THE RESTRAINED BOWING OF A NUCLEAR FUEL ELEMENT. W. N. Miller (Reactor Group, United Kingdom Atomic Energy Authority, Springfields (England)). Oct. 26, 1964. 32p. Dep.; $0.90(BIS), 4s. 6d. (HMSO).

An extension is made of the series of elastic solutions to the problem of the restrained bowing of a nuclear fuel element which are contained in TRG Report 441(S). Special attention is given to the problem of a fuel element, simply supported at one end and encastré at the other, bowing due to the combined action of a uniform transverse temperature gradient and applied mechanical loads, with the bowing being either completely or partially restrained by intermediate grids placed at points on the fuel element longitudinal axis. (auth)

25710 (UNC-5063) EVALUATION OF APPROXIMATE METHODS FOR PREDICTING TRANSIENT TEMPERATURES IN UO_2 AND UC FUEL ELEMENTS. C. C. Graves and H. Firstenberg (United Nuclear Corp., White Plains,

N. Y. Development Div.). May 11, 1964. Contract AT (30-1)-2832. 51p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A description of the heat transfer model, the major assumptions, and the differential equations and boundary conditions for describing transient heat transfer in the fuel, bond, clad, and coolant are presented. Two simplifications to the fuel region conduction equations are discussed. These are the improved lumped parameter equation developed by Elrod, and the standard approximation. Estimates of errors arising from use of the Elrod method and the standard approximation for calculating transient fuel temperatures in ceramic fuel elements are presented. A series of test calculations were made for $\frac{1}{4}$-in. diameter UO_2 and UC fuel rods with constant surface temperature, subjected to power excursions without reactivity feedback. The power excursions considered were: (1) stable period exponential increases in power with periods of 0.1, 0.2, 0.5, 1.0, and 2.0 sec, and (2) prompt jumps followed by stable period exponential increases in power corresponding to step insertions in reactivity of 20, 50, and 80¢. Errors arising from use of the two approximations to the fuel conduction equation were determined from comparison with the exact analytical solution. For UO_2, the results indicated that the Elrod approximation gave significantly less error in predictions of fuel central temperature than the standard approximation. Both methods gave overestimates of the fuel central temperature. In predictions of the fuel mean temperature, the Elrod method again gave significantly less error except for periods less than approximately 0.1 sec and during the short time periods following the prompt jump when the fuel temperature rise was small. The Elrod method gave underestimates of the mean fuel temperature rise, whereas the standard approximation gave overestimates. Similar results were obtained for UC, except that the relative accuracy of the Elrod method increased. Sample values of the errors are presented. Errors arising from neglect of clad heat capacity and thermal resistance were obtained with the ANL finite difference computer code, CYCLOPS. Transient fuel and coolant temperatures were calculated for $\frac{1}{4}$-in. diameter UO_2 and UC fuel rods, clad with 0.018-in. thick stainless steel and cooled by sodium having a velocity of 25 fps, a transport time of 0.1 sec, and an initial temperature rise of 260°F. The power excursions considered were stable period exponential increases in power with periods of 0.5, 1.0, and 2.0 sec. The results indicated that the neglect of clad heat capacity and/or thermal resistance resulted in small (less than about 2%) errors in the predicted mean and central fuel temperatures. However, significant overestimates in the predicted coolant temperature rise were observed for the faster transients. For example, for UO_2, a period of 0.5 sec and a time of 1 sec, neglect of clad heat capacity gave a 10% overestimate in coolant temperature rise. The corresponding overestimate with neglect of both clad heat capacity and thermal resistance was 16%. For UC at the same conditions, the overestimates were 10% and 24%, respectively. Sample values of the errors are presented. (auth)

25711 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Paul Thome (to Commissariat a l'Energie Atomique). British Patent 967,162. Aug. 19, 1964. Priority date Aug. 16, 1962, France.

A "cluster" type fuel element for gas-cooled reactors is designed in which the different "pencils" are held in a definite geometrical arrangement by rigid attachment to one end-grid and by being left free to slide in the second end-grid. Rigid structural elements such as non-fissile central pencils, an outer jacket, and/or tie rods connect the two end-grids. To facilitate pressure reduction of fission gases, free spaces provided in the different pencils are interconnected via minute channels in one of the end-grids. This assembly of free spaces is connected to additional free spaces made in the structural elements connecting the grids. (B.L.M.)

25712 CELL FOR FUEL PLATES. (to Commissariat a l'Energie Atomique). British Patent 967,376. Aug. 9, 1964. Priority date May 2, 1961, France.

A reactor fuel plate cell intended for vertical positioning in the core is comprised of two spaced apertured cheeks for receiving fuel plates therebetween and a plurality of junction elements extending between the cheeks to locate the plates. A pressure device is provided adjacent to one end of the cell by means of which plates in the cell may be urged toward the other end of the cell. A tubular ferrule is provided at the end of the cell remote from the pressure device. The ferrule extends between the cheeks and presents a part spherical external surface for reception by a complementary seat in a support plate in the reactor. (B.L.M.)

25713 NUCLEAR FUEL ELEMENT. Bernard Boudouresques (to Commisariat a l'Energie Atomique). British Patent 967,427. Aug. 19, 1964. Priority date Aug. 20, 1962, France.

A nuclear fuel element of the sheath type disposed in a jacket of a material of low neutron absorption coefficient is designed to eliminate the force exerted on the lower plugs during reactor operation at high temperatures. The longitudinal centering partitions are extruded integrally with the can or sheath of the cartridge, and the longitudinal edges of the partition are recessed in toothed form. Thus the cartridges can be screwed into continuous helical grooves in the inside surface of the jacket. A small radial clearance is provided during assembly between the teeth and the base of the grooves to permit free differential expansion of both during reactor operation. The clearance varies from a minimum at the upper part of the cartridge to a maximum at the lower part. (B.L.M.)

25714 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Wellesley Ashe Kealy, Richard Smart, and Edward Duncombe (to United Kingdom Atomic Energy Authority). British Patent 967,473. Aug. 19, 1964. Filed Mar. 6, 1961.

A nuclear fuel element is provided with an acoustic resonator having a temperature dependent frequency in good thermal contact with the element so as to be temperature dependent upon the element. Preferably the acoustic resonator is a double Helmholtz resonator, and means are provided to determine the resonant frequency. (B.L.M.)

25715 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Gerald Sumner and Lewis Rhoslyn Williams (to United Kingdom Atomic Energy Authority). British Patent 968,039. Aug. 26, 1964. Filed Aug. 27, 1962.

A nuclear reactor fuel element consisting of a thin-walled metallic sheath containing discrete bodies of nuclear fuel material (e.g. UC or UO_2) is internally pressurized with both ends of the sheath being closed. The internal pressure of approximately 50 psi prevents collapse of the sheath on to the enclosed fuel bodies due to creep of the sheath under external pressure at reactor operating temperatures. Either He or a He-Ar mixture may be used to pressurize the fuel element. (B.L.M.)

25716 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ASSEMBLIES. Ernest Edward Jerkins and Donald Garden Taylor (to United Kingdom Atomic Energy Authority). British Patent 977,544. Dec. 9, 1964. Filed Dec. 10, 1962.

An improved fuel assembly stringer comprises end stacked fuel assemblies made up of clusters of sheathed fuel elements of elongate form. The fuel elements are threaded together onto a rod for lifting the stringer as a unit, and the rod is comprised of a series of outer tubular members and withdrawable inner locking means. The tubular members are linked together by demountable coupling means so that when the inner locking means is withdrawn the fuel assembly stringer may be separated. (B.L.M.)

25717 A DEVICE FOR CLOSING THE END OF A TUBE OR PIPE. (to European Atomic Energy Community). Brit-

ish Patent 978,377. Dec. 23, 1964. Priority date Apr. 4, 1962, Italy.

An expandable collet introducible into the end of a tube is patented as a closure device for the end of fuel element tubes or some other thin walled tubes or tubes made of fragile material. The collet is internally tapered, and a collet-expanding element externally tapered to fit within the collet is movable axially of the collet to expand it against the tube. Since the angle of taper is less than the angle of friction between the expanding element and the collet, the element is self-locking in place. A support that has an internal lip surrounds and supports the tube externally and makes a seal with the outer end of the collet, which has a convexly curved cross section where it bears on the lip. (B.L.M.)

25718 IMPROVEMENTS IN FUEL RODS FOR NUCLEAR REACTORS. (to European Atomic Energy Community). British Patent 978,737. Dec. 23, 1964. Priority date June 20, 1962, Belgium.

A fuel rod of the sheathed type is described in which the sheath of stainless steel is of such a thickness (preferably 0.05 to 0.06 mm) and shape that it is flexible and inwardly deformable around the fissionable material in the form of rods or a stack of slugs or pellets under the external fluid pressure of the reactor. A filling material, e.g. Mg or Mg alloys, forms a layer between the fuel and sheath and is viscous or liquid at the operating temperature of the rod. The fuel and the filling material layer form an assembly within the sheath that hydrostatically supports the sheath over the whole of the internal surface, and the sheath may deform to various shapes in accordance with changes in shape of the filling material layer caused by thermal and mechanical stresses induced in the fuel. (B.L.M.)

25719 NUCLEAR REACTOR FUEL ELEMENTS. William Paul White (to United Kingdom Atomic Energy Authority). U. S. Patent 3,146,528. Jan. 5, 1965. Priority date Jan. 14, 1960, Great Britain.

A nuclear reactor fuel element enclosed in a protective sheath is provided with a means for detecting the onset of localized swelling of the sheath associated with a leak. A hollow frangible body is attached to the outside of the sheath so that local asymmetric swelling of the sheath will impart a bending movement to the body, and the body will fracture when a given limit is reached. A detectable substance contained within the body is released on fracture of the body. (A.G.W.)

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Refer also to abstracts 24904 and 24906.

25720 (BMI-1720) MODEL STUDIES OF FLOW IN PWR CORE-2 FUEL ASSEMBLIES. Lawrence J. Flanigan, Clarkson L. Coffin, and William D. Beck (Battelle Memorial Inst., Columbus, Ohio). Mar. 30, 1965. Contract W-7405-eng-92. 34p. Dep.; $1.00(cy), 1(mn) CFSTI.

Approximately 3.5-scale flow models, utilizing air as the working fluid, were used to determine the magnitude of channel-to-channel flow maldistribution within the PWR Core 2 seed and blanket fuel assemblies which occurred as a result of the geometric transition from a circular to a square cross section upstream of the coolant-channel inlets. Channel flow-distribution data were obtained by comparison of the flow distribution obtained with a uniform velocity over the entrance to all coolant channels with that obtained with the round-to-square transitions installed upstream of the fuel clusters. Channel-to-channel flow maldistribution in both the seed and blanket fuel assemblies was determined for four levels of fuel-channel resistance ranging from 10 to 100 per cent of reactor fuel pressure loss. Flow maldistribution in the blanket fuel channels was also determined for various flow-control-orifice settings. The flow distribution data are presented in curve form on plane views of the fuel clusters. (auth)

25721 (CVNA-220) REACTOR RESPONSE ANALYSIS BY LOAD CHANGES WITH AND WITHOUT AUTOMATIC CONTROL. J. J. Loving (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1965. Contract AT(30-1)-2289. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The results of transient tests made at the Carolinas-Virginia Reactor are presented. These include transient tests without automatic control, tests for evaluation of the automatic control system, and load rejection tests. Responses of the more significant plant parameters to step and ramp changes in secondary load are plotted. Overall conclusions concerning the plant response and adequacy of the automatic control system are given. Results of the tests were found to compare very closely to prior simulations, except that response times in the actual plant were generally longer than those in the simulations. (auth)

25722 (CVNA-223) CAVIAR—CAROLINAS VIRGINIA ANALYSIS AND DATA REDUCTION CODE. Raymond J. Nath (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1965. AT(30-1)-2289. 162p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

A detailed explanation of the mathematics and procedures used in the CAVIAR code is given, along with the method of inputting quantities to the code in order to analyze flux wire data from the Carolinas Virginia Tube Reactor. (auth)

25723 (GA-5036) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Period Ending March 31, 1964. (General Atomic, San Diego, Calif.). Apr. 30, 1964. Contract AT(04-3)-187. 51p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Progress is reported in engineering and physics studies of BeO–ThO_2–UO_2 and BeO–PuO_2–ThO_2 fuel bodies for the Advanced Beryllium Oxide Concepts program. (W.L.G.)

25724 (HW-82658) MEASUREMENT OF GAMMA HEATING IN PRTR. FINAL REPORT TEST 82. G. A. Fick (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 8, 1964. Contract AT(45-1)-1350. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An attempt was made to measure the gamma and neutron induced heating of aluminum in the core of the PRTR during shutdown and normal operation. The temperature of a prototype aluminum Vertical Flux Monitoring Probe, H-3-14836, during operation of the reactor was determined, and it was shown that the aluminum tube would not be weakened from excessive temperatures. (C.E.S.)

25725 (NAA-SR-Memo-10596) DETECTION AND IDENTIFICATION OF FAILED MODERATOR ELEMENTS IN THE HNPF CORE FROM OPERATING DATA. R. M. Mills (Atomics International, Canoga Park, Calif.). Oct. 22, 1964. Contract [AT(11-1)-Gen-8]. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Analysis of HNPF operating data has established that a number of major core anomalies occurring over the eight months from February through September, 1964 have been caused by the failure and sodium flooding of nine moderator elements. These failures resulted in reactivity losses totaling about 151 cents. Three principal means of detection and identification of the failed moderator elements were used: (1) a continuous reactivity history calculation which showed a reactivity loss whenever a moderator element failed; (2) comparisons of relative power distributions across the core which showed widespread power depressions centering around the failed moderator elements; and (3) an unbalance, "tilt," in nuclear power channel reading around the outside edge of the core. The first two calculations are performed on a routine basis. (auth)

25726 (ORNL-3731) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1964. (Oak Ridge National Lab.,

Tenn.). Feb. 1965. Contract W-7405-eng-26. 316p. Dep.; $7.00(cy), 6(mn) CFSTI.

The development programs are summarized in nine sections. Separate abstracts were prepared for eight. The section for which no abstract was prepared consists of a table of planned AVR-German reactor fuel capsule irradiations. (J.R.D.)

For abstracts of individual sections see: 24922, 25051, 25052, 25053, 25054, 25687, 25727, and 25761.

25727 (ORNL-3731(p.252-71)) COMPONENT DEVELOPMENT AND TESTING. H. W. Savage (Oak Ridge National Lab., Tenn.).

The first blower for the main coolant of the EGCR was received at the site. The second blower is undergoing performance tests at the vendor's plant. Tests of the blades of the blowers indicated that they can withstand the stresses of blower surging. The pressure-vessel cooling-system compressors were completed and are being prepared for shipment to the EGCR site. These compressors will be evaluated in tests at the site. Performance testing of the control-rod drive mechanism was completed. The tests included 30 insertion-withdrawal operations through full rod travel, 2060 insertion-withdrawal cycles over 4 in. of travel, a test of the slack-cable switch, 300 scram tests from various rod heights, 300 cycles of rapid motor reversal, and rod insertion-withdrawal cycles in a bowed and tilted channel. During these tests the drive mechanism operated satisfactorily for approximately 609 hr in He. A simulated fuel channel that included prototype top and bottom dummy assemblies and two fuel element and graphite sleeve assemblies was set up for coolant flow-distribution and pressure-drop tests. The flow distribution between the moderator annulus coolant and the fuel coolant was obtained for 1-, 5-, and 10-psi pressure differentials across the channel. Flow and pressure-drop data were also obtained for various settings of the adjustable orifice of the bottom dummy. A graphite sleeve with the dimensions of an EGCR fuel element sleeve was exposed to steam at approximately 1500°F for 790 hr. Steam-graphite reaction rates were obtained in terms of the weight of C burned per unit time per unit of internal surface area of the sleeve. Inspection of the sleeve after the test revealed that the structural strength of the graphite had deteriorated so badly that the sleeve crumbled in many places. A similar sleeve was exposed to steam for 24 hr at 1400°F to more nearly simulate the postulated EGCR accident conditions. This sleeve appeared to be structurally sound after the test. (auth)

25728 (ORNL-TM-1111) FUEL CYCLES FOR HIGH-TEMPERATURE GAS-COOLED REACTORS UTILIZING PLUTONIUM. R. S. Carlsmith and W. E. Thomas (Oak Ridge National Lab., Tenn.). Apr. 14, 1965. Contract W-7405-eng-26. 11p. (CONF-650606-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of Brussels

Calculations were made of burnup, conversion ratio, and fuel-cycle cost for high-temperature gas-cooled reactors fueled with plutonium-thorium and moderated by graphite. Recycle of the uranium and plutonium, recycle of the uranium only, and non-recycle were considered. The highest conversion ratios (e.g., 0.9 at a burnup of 50,000 Mwd/t) were obtained with recycle of the uranium only. An assumed plutonium cost of $10.00/g fissile gave minimum fuel-cycle costs of 0.8 mills/kwh(e) both for the non-recycled fuel and for the recycle of the uranium only. The fuel-cycle costs would be lower than those from uranium-thorium fuels at any plutonium cost below $11.00/g fissile. (auth)

25729 (ORNL-TM-1112) FUEL-CYCLE COST COMPARISONS FOR HIGH-TEMPERATURE GAS-COOLED REACTOR FUELS. R. S. Carlsmith, C. M. Podeweltz, and W. E. Thomas (Oak Ridge National Lab., Tenn.). Apr. 14, 1965. Contract W-7405-eng-26. 18p. (CONF-650606-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

Calculations were made of the burnup, conversion ratio, and fuel-cycle cost over a wide range of fuel compositions and fuel management modes for semi-homogeneous uranium and uranium-thorium fuels. A limited series of heterogeneous lattices was also investigated in connection with low-enrichment uranium fuel. Lowest fuel-cycle cost [0.88 mills/kwh(e)] for an economy containing large-scale low-cost fabrication and reprocessing facilities was found to be the uranium-thorium recycled fuel. For near-term economics with high fuel fabrication costs, lower fuel-cycle costs may be obtained from a semi-homogeneous partially enriched uranium fuel operated on a throw-away cycle. No advantage was found for a heterogeneous low-enrichment uranium fuel cycle in a high-temperature gas-cooled reactor. (auth)

25730 (TID-21653) HALLAM NUCLEAR POWER FACILITY MONTHLY OPERATING REPORT NO. 29, DECEMBER 1964. (Consumers Public Power District, Hallam, Neb.). Contract AT(11-1)-513. 67p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The reactor was shut down during the entire report period. Preparations for moderator element removal were continued with the major effort being expended on fuel removal, borescoping of process channels, and induction probing of process channels to locate failed moderator elements. Details of plant activities during the period are included. (J.R.D.)

25731 (TRG-Report-894) DISCOUNT D—AN IMPROVED VERSION OF THE COMPUTER PROGRAM FOR ECONOMIC ASSESSMENT OF NUCLEAR POWER SYSTEMS. G. Black (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Jan. 3, 1965. 24p. Dep.; $0.60(BIS), 3s. (HMSO).

A computer program for IBM 7090 in Fortran II language is described which calculates, among other things, the discounted unit cost of electricity sent out from a wide range of national nuclear power programs. The computer program represents an extension, with modifications, of the program described in TRG Report 198(R) for the Ferranti Mercury computer. In the IBM 7090 version, there are twice as many reactor types as in the previous work and the new program makes possible more detailed study of the effect, on discounted unit cost of electricity sent out, of the inclusion of varying proportions of nuclear to total generating capacity. The costing of conventional power stations is incorporated. Details of the computer calculation and the way in which the program works are given, and the major differences between the Mercury and IBM 7090 programs are pointed out. (auth)

25732 (TRG-Report-917) ARGOSY RESULTS FOR THE LONG-TERM IRRADIATION CHANGES IN THE CALDER HALL REACTOR. C. F. Griggs (Reactor Group, United Kingdom Atomic Energy Authority, Sellafield (England)); and R. Richmond (Atomic Energy Establishment, Winfrith (England)). Jan. 6, 1965. 11p. Dep.; $0.30(BIS); 1s. 9d. (HMSO).

The measured values of the heavy isotope contents of irradiated Calder fuel elements are compared with ARGOSY calculated values. Agreement is satisfactory within experimental errors which are of the order of 1 – 1½%. Since most of the neutron captures in ^{238}U occur below the resonance energy region it is not possible to use this comparison to check the validity of the factor 0.9 applied to the resonance integral of the program ARGOSY 2A and later versions. (auth)

25733 (WAPD-LPR-141) LARGE POWER REACTOR PROGRAM. Interim Report. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1963. Contract AT(11-1)-Gen-14. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Activities in a program to determine the potential of seed-blanket reactors for application in 500-MW(e) central-station power plants are reported. Efforts were devoted to both the U and Th systems, and specific seed-blanket core conceptual designs were evolved, such as the U converter-burner, Th converter-burner, U con-

verter-recycle. Results at this stage indicate that the Th seed-blanket converter-burner is the most attractive design. Design work is continuing. (J.R.D.)

25734 (WAPD-LPR-154) LARGE POWER REACTOR PROGRAM. SUPPLEMENT. THE DESIGN OF SEED-BLANKET CORES. Interim Report. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1963. Contract AT(11-1)-Gen-14. 191p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

Physics development work on LPR is reported. The analytical methods employed to calculate reactivity power distribution, and fuel depletion are summarized. The information is presented in sections on neutron economics, reactivity control, $^{235}U/^{238}U$ systems, $^{235}U/^{232}Th$ systems, Th-cycle breeding feasibility, verification of nuclear design, core mechanical design, fuel element design and performance, core thermal performance, reactor vessel design and fabrication, control drive mechanism design, core instrumentation, fuel handling, steam cycle analysis, reactor plant analysis, and reactor containment. Nuclear data employed in LPR calculations are also included along with information on fission product poisoning, survey analytical models, characteristics of seed-blanket configurations, and fuel cycle costs. (J.R.D.)

25735 STARTUP OF BOILING REACTOR VK-5 OF ULYANOVSK NUCLEAR POWER STATION. A. Kubrichenko and V. Parfir'ev. At. Energ. (USSR), 18: 302(Mar. 1965). (In Russian)

Descriptions are given of the startup of a 70 Mw(e) boiling power reactor operating with three loops for reheating steam in a steam generator. The reactor operates at pressure ranges from 35 to 100 atm. The reactor active zone is 2 m in height and 2.7 m in diameter and housed in a 3.8 m in diameter and 11 m high stainless steel-clad cylinder vessel. The active zone of the reactor consists of rods of 1.5% enriched uranium. (R.V.J.)

25736 LEAD SHIELDING: MAJOR CONTRIBUTION TO THE BRITISH NUCLEAR POWER PROGRAMME. E. R. Newson (Associated Lead Mfg. Ltd., Chester, Eng.). Nucl. Energy, 80-3(Mar. 1965).

The factors influencing the selection of shielding materials for the Trawsfynydd power plant are summarized and the methods used in the fabrication and erection of the lead shielding are described. (D.C.W.)

25737 NUCLEAR DEVELOPMENT IN INDIA. S. K. Biswas. Nucl. Energy, 87-96(Mar. 1965).

The nuclear power program of India is discussed, with consideration of progress to date, comparative costs, energy demands and resources, and the first nuclear power plant to be constructed at Tarapur. (auth)

25738 CHERENKOV RADIATION IN A REACTOR WITH WATER MODERATOR. M. Nachman and G. Glanz. Rev. Roumaine Phys., 9: 723-31(1964). (In Russian)

The dependence of the intensity of Cherenkov radiation in a water-moderated reactor was studied to determine if it can be utilized to follow the power of the reactor. The radiation intensity is proportional to the reactor power, but it was not possible to establish a simple relation between the intensity of the Cherenkov radiation and the reactor power during several days of operation in variable regime. It is concluded that this effect can be used to advantage only for the study of the period of power increase or for the control of a maximum protection relay. (tr-auth)

25739 DESCRIPTION AND APPLICATION OF THE MH-1A FLOATING NUCLEAR POWER PLANT. Richard A. Farmer (Army Engineers, Fort Belvoir, Va.) and Gerald W. Chase. 38p. (CONF-640810-9)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

The MH-1A floating power plant is mounted in a converted liberty ship hull and uses a pressurized water reactor, which is coupled to a conventional steam-electric generating system to deliver power to land-based installations. A description is given of the hull characteristics, collision and grounding protection, and ships service system for the floating mount; the steam-electric system, primary system, containment, shielding, disposal of radioactive waste, instrument and control, and refueling for the power plant. The project schedule and the projected use are discussed. Diagrams are included. (L.B.S.)

25740 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Electric Co.). British Patent 966,874. Aug. 19, 1964. Priority date Mar. 18, 1960, United States.

A nuclear power reactor is designed to have substantially increased power output and power density capabilities by substantially eliminating local neutron flux and power peaking. A fission chain reacting assembly is provided that includes a cellular reactor core structure providing elongate, parallel, neutron moderating coolant passages. Each passage extends from an inlet opening at one end of the structure to an outlet opening at the other end. The flow passages have substantially the same geometric cross section. Fuel elements are supported in a sufficient number of the passages to maintain a self sustaining chain reaction in the presence of the neutron moderating coolant liquid. Substantially the same moderator-to-fuel ratio is maintained in each fuel element assembly. At least one movable control poison element is provided. (B.L.M.)

25741 FLUID COOLED NUCLEAR REACTOR PLANT. Alfred Brunner (to Sulzer Freres). U. S. Patent 3,162,581. Dec. 22, 1964. Priority date Apr. 11, 1960, Switzerland.

In the fluid-cooled nuclear reactor plant described, advantage is taken of the inherent nonuniform heat generation to improve the thermal efficiency of the plant. The fuel-containing cooling tubes are divided into groups according to the amount of heat generated therein. Relatively cool fluid is conducted through the tubes generating most heat and hotter fluid through those generating less heat. A heat-consuming system is provided, which receives relatively hot fluid primarily heated by fuel elements in a relatively hot zone of the reactor and additionally heated by fuel elements in a relatively cool zone of the reactor. (A.G.W.)

25742 COMPACT MOBILE NUCLEAR POWER PLANT. Joseph R. Wetch, Herman M. Dieckamp, and Monte V. Davis (to North American Aviation, Inc.). U. S. Patent 3,164,525. Jan. 5, 1965. Filed May 4, 1960.

A compact, mobile, hermetically sealed power-producing system utilizing a nuclear reactor is capable of providing 2 Mw(e) net for a minimum full power core life of 5000 hr. The boiling-water-cooled reactor has a zirconium hydride moderator homogeneously containing fissionable material and operates in the epithermal neutron energy range. It has a small steam concentration in the core and a steam exit quality of at least ~10% with a 10:1 recirculation ratio. (A.G.W.)

25743 NUCLEAR REACTOR VAPOR GENERATING PLANT. Alfred Brunner (to Sulzer Freres). U. S. Patent 3,164,527. Jan. 5, 1965. Priority date Apr. 28, 1961, Switzerland.

The coils of a heat exchanger through which the working medium of a nuclear reactor plant is conducted are so arranged that there is a countercurrent of the operating medium with respect to the reactor coolant, which is the heating agent in the heat exchanger. The reactor is subdivided into zones generating different amounts of heat and having different coolant inlet and outlet temperatures. The coolant is fed to and discharged from the heat exchanger through pipe lines at different stations according to its temperature. The heat exchanger is subdivided into at least two parts through which the coolant flows successively and between which parts a blower is provided for circulating the coolant through the heat exchanger and through the reactor. The arrangement is intended to produce optimum thermal efficiency. (A.G.W.)

25744 NUCLEAR REACTOR POWER MONITOR. Samuel Untermyer, II (to General Electric Co.). U. S. Patent 3,165,446. Jan. 12, 1965. Filed Dec. 26, 1962.

A method is patented for monitoring the power distribution throughout a nuclear chain reacting assembly dis-

posed in a reactor vessel and having liquid coolant flowing through the fuel-containing channels. Penetrating radiation emitted axially from a relatively small local region of the assembly is collimated and measured at a point outside the vessel. The core region monitored may be a single selected fuel-containing channel or a group of channels adjacent one another. The radiation attenuation varies with changes in density and temperature of the coolant, which in turn varies with the power level of the reactor; therefore, the radiation intensity is a direct function of the power level. The axial power distribution can thus be determined by detecting the collimated penetrating radiation emitted at a sufficient number of points. (A.G.W.)

Process Heat Reactors

25745 PROSPECTS FOR USE OF NUCLEAR ENERGY FOR PRODUCTION OF LOW-TEMPERATURE HEAT. S. Baldetti, L. Biondi, N. Cerullo, R. Di Menza, B. Guerrini, L. Lazzarino, L. Pierazzi, and A. Vaudo. Comit. Nazl. Energia Nucl., Notiziario, 11: No. 2, 18-27(Feb. 1965). (In Italian)

The major problems connected with the requirement of low-temperature heat for industrial applications, home heating and water desalting are reviewed. An appraisal is made of the technical feasibility and economic aspects of the use of nuclear energy in such applications. In the power and steam characteristics range which suits these applications best, the organic-cooled nuclear reactor seems to be particularly interesting and worth developing to this particular end. After a preliminary review of the most promising lines of development of an organic-cooled reactor intended for the production of low-temperature heat, the tentative conceptual design for a reactor of this kind is discussed. (auth)

25746 THE EFFECT OF THE INDUSTRIAL PRICE REFORM ON THE ECONOMY OF NUCLEAR ENERGY. K. Schwarz (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 8: 167-71(Mar. 1965). (In German)

The permissible investment cost for nuclear heating stations is estimated, when the initial cost of heat produced in conventional heating stations should not be exceeded. In regions far-away from coal mines, nuclear heating stations will be economic at earlier time than nuclear power stations, when the thermal power of the heating stations will be comparable to those of the power stations. (P.C.H.)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

Refer also to abstracts 24675, 24880, and 24883.

25747 (HW-84369(p.21-4)) SHUTDOWN CHARACTERISTICS OF U^{233}, U^{235}, AND Pu^{239} PROPULSION REACTORS. W. W. Little (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The reactor shutdown rates were compared for specified reactivity variations. (J.R.D.)

25748 (LA-DC-6837) OPTIMAL NUCLEAR ROCKET ENGINE CONTROL. Ronald R. Mohler (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 12, 1965. Contract W-7405-eng-36. 35p. (CONF-650413-2). Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Neutron Dynamics and Control, Tucson, Ariz.

The problem of controlling a nuclear rocket engine so as to minimize propellant consumption is analyzed. It is shown that the required control consists of a maximum allowable effort process. That is, reactivity and propellant flow rate must be varied so that one or both are at a maximum or minimum allowable value while the state of the system is inside some constraint boundary in the state space. To keep the trajectory on such a state-constraint boundary, however, it is required that reactivity and/or flow rate must vary appropriately. Though ostensibly a minimal-propellant consumption process, the control is also one of minimal time. In addition to constraints in reactivity and flow rate, other necessary physical constraints (such as constraints in reactor power, rate of change of core temperature and pump performance) are considered. These constraints considerably complicate the analysis and synthesis of the optimal control. The analysis is made with Pontryagin's maximum principle (along with the extensions for state-constrained problems) and physical arguments. The system dynamics are defined by a single-lump, direct-cycle, heat-exchange process and a monoenergetic neutron kinetics model. It should be recognized that such a model only approximates the dynamic behavior of an actual engine. The optimal control, on the other hand, requires precise information in order that the state can be confined to some constraint boundary when necessary. Inaccuracies in the model and measurement (or estimation) of the state variables indicate that a suboptimal, closed-loop process may very well be in the best practical control. Such a closed-loop system would also attenuate noise effects. With a knowledge of the optimal process, it is shown that conventional closed-loop control can be synthesized so that its performance nearly approximates the optimal performance, and such control may thereby be classified as suboptimal. (auth)

25749 (NP-15022(Vol.I)) SNAP-8 RADIATION EFFECTS TEST PROGRAM. VOLUME I. GAMMA SPECTRUM MEASUREMENTS. (Lockheed-Georgia Co., Marietta). Sept. 1964. For Aerojet General Corp., Azusa, Calif. Subcontract OP367736. 20p. (ER-7448)

The gamma spectra of the Radiation Effects Reactor was measured with three external shield configurations, i.e., 16 inches of lithium hydride, 16 inches of lithium hydride plus 8 inches of water, and 8 inches of water. These measurements were made with a collimated single crystal sodium iodide scintillator (4 in. × 5 in. diameter). Histogram photon and dose distributions were then computed by means of a 33 × 33 inversion matrix. These measurements show considerable hardening of the basic reactor spectrum, i.e., the U-235 fission spectrum plus capture gammas for the reactor coolant and structural materials. Data reveals that lithium hydride is not unique in shaping the resultant filtered spectra, but instead demonstrates effects similar to those produced by water. The measured dose distribution shows qualitative agreement with the calculated SNAP-8 environment. (auth)

25750 (NP-15022(Vol.III)) SNAP-8 RADIATION EFFECTS TEST PROGRAM. VOLUME III. COMPONENTS AND SUB-ASSEMBLIES. (Lockheed-Georgia Co., Marietta). Jan. 1965. For Aerojet-General Corp., Azusa, Calif. Subcontract OP367736. 315p. (ER-7644)

Irradiations of selected components and subassemblies were carried out at 100 and 160°F in the Radiation Effects Reactor. The components included low- and high-current diodes, SCR's, resistors, and capacitors. The subassemblies included voltage sensing, 4- and 8-diode frequency sensing, magnetic amplifier, and SCR trigger and control subassemblies. (D.L.C.)

25751 (TID-21212) THERMAL INSULATION TEST. CNSG REACTOR STUDIES. Research Report No. 5451. T. E. Hollowell (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Jan. 20, 1964. Contract AT(30-1)-3198. 82p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A test program was conducted to find, and demonstrate the feasibility of, a thermal insulation for the Consolidated Nuclear Steam Generator. This material must be capable of providing adequate thermal insulation when flooded with water. Three materials were evaluated in heat transfer-corrosion test; silica sand, rigid foamed glass, and stainless steel powder. From these tests the following can be concluded: (1) Silica sand with no internal baffles gave heat loss rates which were unacceptable; (2) Rigid foamed glass gave heat loss rates which were excessive and the insulation also cracked into small pieces during the test; and (3) Stainless steel powder was able to provide satisfactory

thermal insulation, but the powder was suspended in the steam that leaked out around the flanges. (4) Silica sand with vertical baffles in the insulation space will provide the thermal insulation required when flooded with water. The maximum over-all heat loss rate was 2900 Btu/hr-ft^2 with a steady state internal vessel temperature of 544°F. (5) The corrosion tests on copper–nickel alloys caused only slight discolorations on these materials. The carbon steel specimens were oxidized and had deposits formed on them. The carbon steel specimens with Amercoat protective coating withstood the containment water test very well but the coating was cracked and peeled off the specimens in the insulation space. (6) The maximum stresses in the insulation container, at the tenth cycle, were only 20 per cent of the predicted values, assuming silica sand to be incompressible. (D.L.C.)

25752 NUCLEAR HEATING AND PROPELLANT STRATIFICATION. Edward E. Duke (Aerojet-General Corp., Sacramento, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 760-2(Apr. 1965).

An analysis is outlined of propellant stratification in a cylindrical, cone-bottomed tank accelerating along its longitudinal axis and subject to wall, ullage, and nuclear heating. (D.C.W.)

25753 RELIABILITY IN ADVANCED DEVELOPMENT PROGRAMS. M. M. Yarosh. Nucl. Safety, 6: No. 2, 160-4 (Winter 1964-65).

Development of reactor power systems capable of meeting the expected need for power in the nation's future space program activities is discussed. Conceptual design for reliability and detailed design and development problems are considered. Fundamental reliability is discussed. (M.C.G.)

25754 DEVELOPMENT OF A RADIATION TOLERANT ALL SOLID STATE TRACKING AND COMMAND SYSTEM. E. A. Smith. 18p. (CONF-641009-14)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

The radiation hardening aspects of the development of a Doppler command and tracking system for the SNAP 10A nuclear power system is discussed. The purpose of the command and track system is to receive and decode binary commands, to transmit a cw signal coherent with a received signal for the purpose of obtaining Doppler data, and to transmit a cw signal to tracking. The successful operation of the system during orbital operation in an environment of neutron and gamma leakage flux from the onboard reactor represents a variety of hardened linear and nonlinear all solid state circuitry including transmitter-receiver operations in the 400 Mc region. A block diagram of the system is shown. (L.B.S.)

25755 N. S. SAVANNAH OPERATING EXPERIENCE FOR THE PERIOD MAY 1963 TO AUGUST 1964. D. L. Cook and C. P. Patterson (Dept. of Commerce, Washington, D. C.). 29p. (CONF-640810-7)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

The accomplishments made on the objectives of the Savannah program to demonstrate to the world the interest of the United States in the peaceful application of atomic power, and to provide a vehicle which would establish the procedures and precedents for possible future operations of commercial nuclear ships are given. The operating problems, port entry requirements, port surveys and port operating plan, foreign port acceptance, and agreements with foreign governments are discussed. Consideration is given to future alternative uses of the ship after completion of port visitations. (L.B.S.)

25756 SAVANNAH SERVICING FACILITIES AND TECHNICAL SUPPORT STAFF. T. M. Christian and C. E. Thomas. 32p. (CONF-640810-2)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

The facility built at Galveston, Texas, for servicing the N. S. Savannah is briefly described, and the activities and organization of the technical staff established to support the operation of the ship are outlined, including training, engineering services, maintenance, safety modifications, safety analyses and tests, and core physics tests. (D.C.W.)

25757 REVIEW OF CNSG MARINE REACTOR PROGRAM. G. A. Sawyer (Virginia Polytechnic Inst., Blacksburg, Va.). Babcock and Wilcox Co., Lynchburg, Va.). 23p. (CONF-640810-3)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

The development and status of the Consolidated Nuclear Steam Generator design are summarized. A 20,000-shp version of the present design (CNSG III) is described, with a brief consideration of a 70,000-shp plant was well. (D.C.W.)

Research and Test Reactors

Refer also to abstracts 24612, 24841, and 24953.

25758 (AERE-M-1518) PROCEDURE FOR INTENDING USERS OF THE HARWELL REACTORS. A. E. Truswell (Atomic Energy Research Establishment, Harwell (England)). Dec. 1964. 20p. Dep.; $0.70(BIS); 3s. 6d. (HMSO).

A description is given of the procedure at the Atomic Energy Research Establishment, Harwell, for examining the safety aspects of all experimental irradiations in the establishment's research reactors. Before any experiments are carried out the experimentalist, commonly called the User, must satisfy the Reactor Manager that the experiment will not endanger the reactor or personnel. In some cases, the Reactor Manager seeks the advice of a committee of scientific and engineering specialists, set up for this purpose, before he agrees to accept an experiment. In all cases, a full assessment must be made of the safety of the experiment along the lines indicated. This procedure is not required for the irradiation of small amounts of material requiring only the use of existing standard irradiation equipment. In such cases the User completes an Irradiation Request Form of the type shown. (auth)

25759 (HW-84369(p.39-43)) MEASUREMENTS OF SPECTRAL INDICES IN THE PLUTONIUM RECYCLE TEST REACTOR. L. C. Schmid (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results are presented of PRTR data analyses using shapes for joining functions based on spectral calculations for 19-rod clusters of Pu–Al and UO_2. The spectral index values are higher by 15°K for Pu–Al and 6°K for UO_2 than those obtained from previous measurements using Lu foil. (J.R.D.)

25760 (LA-DC-6891) ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT ON-LINE PROCESS COMPUTER. Howard B. Demuth, Fred P. Schilling, and Larry Weintraub (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 21p. (CONF-650413-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Neutron Dynamics and Control, Tucson, Ariz.

An on-line process computer for the Ultra High Temperature Reactor Experiment (UHTREX) will be used to aid in the operation of the UHTREX reactor, the reactor coolant loops, and the coolant purification system. The computer system includes a central processor with 4000 words of magnetic core memory, 32,000 words of drum memory, an input-output typewriter, and a paper tape punch and readout. There are 4 logging typewriters and one visual display unit. The system can sample some 600 analog and 300 digital inputs, and it can set 444 digital and 24 analog outputs. Twenty interrupt channels will be used to allow time sharing of input-output equipment and to initiate special programs

dependent on UHTREX system conditions. The computer will sample analog channels at a rate of 200 channels per second and monitor them for out-of-limit conditions. It will also prepare logs, perform on-line calculations, keep reactor fuel and other system histories, and monitor reactor operator activities. Capability is being provided for sequencing valves in operations such as full loading and for controlling coolant flow rates, thermal power output of the cooling system, etc. In addition, system diagnostic programs and emergency shutdown programs will be available to help in system operation. (auth)

25761 (ORNL-3731(p.229-35)) STUDIES OF FACILITIES AND EQUIPMENT. (Oak Ridge National Lab., Tenn.).

Tests were run to determine the operating capabilities of GCR-ORR Loop No. 1 in which CO_2 was used as the test fluid. No loop operating limit was encountered up to a mass circulation rate of approximately 2500 lb of CO_2 per hour; however, the clutch capacity on the motor-generator unit supplying the compressor motors presently limits continuous operation to about 1000 lb/hr. A comparison was made between theoretical and experimental analyses of nozzles radially attached to and protruding through a spherical shell. The loadings considered were axial thrust on the nozzle, moment load on the nozzle, and internal pressure. The experimental and theoretical results show general agreement in distribution and magnitude, with good agreement between the maximum values. (auth)

25762 SOME PHYSICAL CHARACTERISTICS OF THE RB-2 RESEARCH REACTOR. F. Benedetti, G. Brighenti, G. Giuliani, and A. Lovati (SNAM, Milan and Universita, Bologna). Energia Nucl. (Milan), 12: 212-17(Apr. 1965). (In Italian)

The operations performed to define some physical characteristics of the RB-2 reactor are described. The operations include: measurement of reactivity of control rods, moderator and reflector; determination of the temperature and void coefficients; measurement of the neutron flux and study of its distribution in the experimental facilities. Checks of the efficiency of scram obtained with different safety systems (spring and gravity-actuated rods with cadmium absorber, dumping of moderator through a quickly opening valve, decrease in moderator bulk density effected by gas injection) are also described. (auth)

25763 RESEARCH IN CERTAIN KINETIC CHARACTERISTICS OF THE IRT REACTOR IN SOFIA BY THE REACTOR OSCILLATOR METHOD. V. Christov, N. Bachvarov, and A. Markov. Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk., 12: 127-36(1964). (In Bulgarian)

Two important kinetic parameters of the IRT reactor in Sofia were determined: the effective participation of delayed neutrons β^* and the average lifetime of prompt fission neutrons in the active zone of the IRT reactor. An improved oscillating method was used. A small, hollow, compensated coaxial boron ionization chamber was used to detect the signal-result, permitting oscillation of the model in one and a same channel of the active zone in close proximity to the detector (below and above the latter), thereby improving the sensitivity of the measuring method. From the l and β^* values (determined experimentally) the reactor's amplitude curves and phase-frequency characteristics were calculated. A correction of the reactor's reaction-curve was also introduced. (auth)

25764 THE POWER INCREASING OF WWR-S RESEARCH REACTOR. V. Zajic (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Kernenergie, 8: 92-8(Feb. 1965). (In German)

Techniques that proved to increase the power level of the 2000 kw research reactor WWR-S, especially from point of view of the cooling system capacity, of fuel element cooling, and of the fuel elements operation ability are discussed. The power increase which shall be carried through to twice the actual value was established, and some further aspects of power increases are shown. (auth)

25765 ARGONNE TRANSIENT REACTOR TEST FACILITY. J. R. Weir. Nucl. Safety, 6: No. 2, 169-71(Winter 1964-65).

The Argonne Transient Reactor Test Facility (TREAT) is described. Fuel element meltdown experiments are discussed and results presented. Metal-water reactions were also studied in TREAT, and the extent of the reaction computed from the amount of hydrogen produced. Particle-size distributions from oxidation of uranium was also studied in TREAT. (M.C.G.)

25766 CABLE BUSHINGS FOR THE MULTI-PURPOSE RESEARCH REACTOR (MZFR). Georg Engelhardt and Erwin Schaufler. Siemens-Z., 38: 646-8(Aug. 1964). (In German)

The specifications for the bushings of the multi-purpose research reactor were summarized, and the criteria that led to the selection of the type of bushing used were indicated. Its construction was described with special consideration of the coaxial cable bushing and the treatment of the sealed bushing elements. (J.S.R.)

25767 MANUAL FOR THE OPERATION OF RESEARCH REACTORS. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 37. Jan. 1965. 208p. STI/DOC/10/37. $4.50; S 94.50; €1.70; F.Fr.18,-; DM 15.75 (IAEA)

Operational, experimental, and functional requirements and characteristics of light-water-cooled, light-water-moderated research reactors are surveyed. Procedural details are emphasized. (T.F.H.)

25768 THE EFFECT OF THE PORT VOID IN THE PREDICTION OF THERMAL NEUTRON BEAM PORT CURRENT. Sanford Charles Cohen. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1964. 178p.

A method is presented for the prediction of the exit thermal neutron current from a reactor beam port. The results of duct experiments at the Ford Nuclear Reactor afford confidence in the validity of the analytical technique. The analysis employs elementary P-1 theory, which is inspired by an examination of the infinite half-space limit. A return current boundary condition at the source plane of the port is developed by summing current contributions from the lateral surfaces. An idealization of the scalar flux distribution along the lateral surfaces of the port permits a diffusion theory solution for the source plane angular flux as a function of the port radius and the unperturbed flux distribution in the medium. Activation measurements of the scalar flux distributions at the source planes of $1\frac{1}{2}$-, 3-, and 5-in. diameter aluminum ducts were performed in light water and graphite. Measurements of the exit current from the ducts, provided with an internal collimator to eliminate wall leakage contributions, were carried out in light water. Comparison of the data with analytical results indicates that the exit current is predicted very well. The source plane scalar flux is predicted with somewhat less accuracy. A background survey for the enhancement of the thermal neutron beam intensity at the Ford Nuclear Reactor is presented in an appendix. Variations in reflector materials and core-reflector configurations were investigated. The results suggest the employment of a D_2O-reflected core in a slab configuration. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25769 CORRELATION OF TWO-GROUP THEORY WITH NEUTRON FLUX MEASUREMENTS IN A POOL-TYPE REACTOR. William Carlton Coppersmith. Thesis, Charlottesville, Va., Univ. of Virginia, 1964. 340p.

Neutron flux measurements were made in the University of Virginia swimming-pool reactor and certain two-group diffusion theory parameters determined by an empirical adjustment to the measurements. Small bare and cadmium-covered ^{235}U foils measuring 0.3 cm^2 in area were employed in obtaining detailed flux distributions for a correlation with fast and thermal theoretical distributions. Measurements were taken along the vertical axis and in the mid-plane of a water-reflected 4 × 4 assembly measuring approximately 30 × 30 cm horizontally and 60 cm vertically.

A two-energy group, two-region, neutron diffusion theory model was employed using cylindrical geometry with the reflector savings approximation. Flux distributions for a side-reflected system were used in the mid-plane correlation while those for an end-reflected system were used for the axial correlation. Over 100 two-group computations were performed for the correlation. A digital computer program was written for the specific two-group model employed. The program included a scheme for obtaining average fast scattering cross sections which were used in conjunction with the dilute resonance integrals for obtaining fast group constants. The best theoretical-experimental agreement was obtained with a value for the fast diffusion area in the core equal to 42.5 cm^2 and a value of 25.5 cm^2 for the fast diffusion area in the water reflector. Radial and axial reflector savings (which include the extrapolation distance) were determined to be 7.7 cm and 6.3 cm, respectively. The theoretical height was fixed to that of the physical core and the radius varied to satisfy the criticality condition. For the above values, the theoretical critical radius was 15 cm. (Dissertation Abstr., 25: No. 6, Dec. 1964)

25770 NUCLEAR CHAIN REACTORS. Richard M. Stephenson. U. S. Patent 3,165,447. Jan. 12, 1965. Filed May 5, 1961.

A nuclear chain reactor intended to research or test use is of the heterogeneous type and has movable fuel elements. The fuel elements may be placed on an endless belt that moves them continuously through the active core, or they may be oscillated up and down. Alternatively, the fuel elements may remain fixed while the reflector is oscillated up and down to establish the chain reaction in different parts of the fuel. In either of these arrangements most of the heat transfer would take place outside of the active zone. (A.G.W.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstract 24767.

25771 (HW-77979) INSTRUMENTATION FOR CALCINER PRODUCT CANISTERS— LEVEL DETECTION. C. E. Huck (General Electric Co., Richland Wash. Hanford Atomic Products Operation). June 27, 1963. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Two different level detection methods have been evaluated for use with calciner product canisters. The first method uses MgO insulated, stainless steel-sheathed, chromel-alumel thermocouples spaced four inches apart vertically for power level detection. A usuable drop of 75 to 100°C in thermocouple temperature occurs when preheated calciner powder at a temperature of about 440°C slowly covers a thermocouple which was previously heated by radiation from the canister wall to a temperature of 550 to 600°C. The second method involves the use of electrical conductivity for melt level detection. The measured 6.4 mho/cm electrical conductivity of the melt is very close to the value predicted from earlier fused salt work and to values obtained from the Handbook of Electrochemical Constants, which ranged from 1.74 mho/cm for KBr to 6.74 mho/cm for LiCl. This conductivity value is suitable for actuating an electronic relay as an incremental level readout method but attempts have not been successful to obtain a conductivity signal proportional to melt level. The high viscosity and incomplete fusing of the melt at temperatures of 600 to 700°C as well as encrusted layers and voids below the surface are probably the reasons for the erratic readings obtained. Each of the two methods, thermocouple temperature excursion, and electrical conductivity measurement, appears to be specific but neither will indicate the other variable; that is, thermocouples will not read out melt level and conductivity probes will not read out powder level. It should be noted that the level measurements so far are preliminary and have been made with detectors at fixed locations and therefore proportional signals have not been obtained. (auth)

25772 (HW-83896) SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE FUEL REPROCESSING WASTES BY SPRAY AND POT CALCINATION—HOT-CELL PILOT PLANT STUDIES. R. T. Allemann, F. P. Roberts, and U. L. Upson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 1964. Contract AT(45-1)-1350. 97p. Dep.; $4.00(CFSTI).

When excess sodium was present in the waste, the loss of cesium was increased during pot calcination. The calcined waste containers did not develop any excess pressure upon storage except when excess sodium nitrate was present in the waste. Fission product distribution in the melted wastes was fairly uniform and in the same ratio as in the liquid waste except for ruthenium losses. (auth)

25773 (HW-84577) SCINTILLATION PROBE RESULTS ON 200 AREA WASTE DISPOSAL SITE MONITORING WELLS. J. R. Raymond and V. L. McGhan (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 17, 1964. Contract AT(45-1)-1350. 62p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Scintillation well probes were used to monitor the subsoil contamination below radioactive liquid waste ground disposal facilities. Results are discussed for the 200-East and 200-West facilities. The results indicate that significant lateral spread of wastes occurs in the sediments beneath the 200 Areas, and that the downward migration rates of gross gamma emitters is relatively slow. (D.L.C.)

25774 (HW-84603) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, October–December 1964. A. M. Platt, ed. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 1965. Contract AT(45-1)-1350. 54p. Dep.; $3.00(cy), 3(mn) CFSTI.

Progress is reported on the following: calcination and solidification studies, waste solidification engineering prototypes, and waste storage and treatment. Individual abstracts were prepared for each topic. (D.L.C.)

For abstracts of individual sections see: 25775, 25776, and 25777.

25775 (HW-84603(p.8-31)) CALCINATION AND SOLIDIFICATION STUDIES. R. E. Burns, C. R. Cooley, and R. L. Moore (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The investigation of the continuous phosphate glass process was continued by three more runs; equipment failure terminated the experiments. With insufficient feed concentration in the evaporator, the sulfuric condensate contained ~5.6% of the ruthenium, and the off-gas was decontaminated by a factor of at least 10^6. Leaching tests were made on phosphate glass and on a Redox borosilicate glass and a Purex phosphate solid produced in the hot spray calciner-melter. The study of phosphate addition indicates an optimum M^+/P ratio in the neighborhood of 2.3 or 1.0. Purex 1WW glass compositions were studied. Materials were evaluated for corrosion resistance to Purex waste–calcium borate at 900°C. The coupled spray calciner and melter was operated with simulated 1WW waste with various fluxes. Various studies in waste storage pot inspection, analog computer solutions, and transient thermal behavior in waste fixation are described. (D.L.C.)

25776 (HW-84603(p.32-6)) WASTE SOLIDIFICATION ENGINEERING PROTOTYPES. C. R. Cooley (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The design and fabrication status of the equipment is described. Major equipment pieces were installed in the cold semiworks facility for design verification tests. Water boilups on both 8- and 12-in. pots have been made and four 8-in. pot calcination runs were completed using the prototype induction furnace. (D.L.C.)

25777 (HW-84603(p.37-49)) WASTE STORAGE AND TREATMENT. G. J. Alkire, R. E. Burns, and W. H. Swift (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Studies were initiated on the precipitation of sulfate from a simulated waste. A 50-day run was made using an electrodeionization unit with an alkaline condensate. It was found that fission product cesium loading in shipping casks may be increased by using AW-500 zeolite in place of the Decalso. The relationship between zeolite SiO_2/Al_2O_3 ratio and Cs and Sr selectivity was determined for several sodium-based zeolites. Vapor pressure vs temperature and concentration data were obtained for three waste compositions which will be subjected to in-tank concentration. A number of special cases in the removal of heat from underground storage vessels were studied. An approximate model was used to calculate maximum tank temperatures in Purex Waste Tanks containing solidified wastes. (D.L.C.)

25778 IMPACT OF LEGAL CONTROL OF DISCHARGE OF RADIOACTIVE MATERIALS ON THE RESPONSIBLE DEPARTMENTS. G. Wortley (Ministry of Agriculture,

Fisheries and Food, London). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 313-29(1964).

Legislative control of the disposal of radioactive wastes is discussed in general terms. Legislation in the United Kingdom covering the discharge of radioactive materials is reviewed in detail. (C.H.)

25779 IMPACT OF LEGAL CONTROL OF DISCHARGE OF RADIOACTIVE MATERIALS ON THE RESPONSIBLE DEPARTMENTS. I. C. Roberts and S. H. Small (International Atomic Energy Agency, Vienna). Food Agri. Organ. U. N., FAO At. Energy Ser., No. 5, 345-66(1964).

Problems involved in the international control of the discharge of radioactive materials resulting from peaceful uses of nuclear energy are reviewed. Current waste disposal practices are described. It is concluded that so far national controls have been adequate for the safeguarding of international interests but that future developments will almost certainly require some form of international agreement for the control of the discharge of radioactive wastes. (C.H.)

25780 DEFENCE REQUIREMENTS FOR PREDICTING DISPERSAL OF RADIOACTIVE CONTAMINANTS IN TIDAL INLETS. S. H. Small (Norwegian Defence Research Establishment, Kjeller, Norway). p.167-76 of "Nuclear Detonations and Marine Radioactivity." Kjeller, Norway, Norwegian Defence Research Establishment, 1963.

In view of the limitations of dose/effect relationships, simple mathematical models should suffice for predicting exposure dose-rates from contaminants released into tidal inlets. Models already developed for predicting mean concentrations of dissolved contaminants in estuaries can be of great assistance, but attention must also be paid to the hazards of contaminants not in solution. (auth)

25781 DECONTAMINATION OF VOLATILE RADIOACTIVE EFFLUENTS. Marshall L. Spector (to Pullman Inc.). U. S. Patent 3,153,566. Oct. 20, 1964. Filed Aug. 28, 1961.

In the process for the decontamination of volatile radioactive effluents during the calcination of reactor wastes, the radioactive wastes are calcined to the corresponding oxides at 300 to 600°C, and the oxides of the volatile radioactive components such as Ru and Ce are drawn off through a cartridge located at the top of the calcining zone and packed with a solid mixture of a metallic oxide and an elemental metal. The metallic oxide is selected from the group consisting of Co, Cr, and Fe; and the elemental metal from the group consisting of Al, B, Zr, and Si. The solid mixture in the cartridge may be withdrawn and heated for fixation or passed into the fixation zone of the apparatus along with the solid oxide wastes from the calcining zone. In the fixation zone the oxides are heated to a temperature of 500 to 1200°C to chemically combine the oxides with a mixture of the same type as that used in the absorption cartridge into a solid fused mass for convenient disposal. (B.L.M.)

GENERAL AND MISCELLANEOUS

25782 (AECL-1580) SCIENCE AT CHALK RIVER. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). [1964]. 51p. Dep.(mn); $1.50(AECL).

A review is presented of the areas in which research by the Science Divisions at Chalk River Nuclear Laboratories is now in progress. These areas include chemistry and metallurgy, physics, reactor research, and biology and health physics. Recent publications in each area are listed. (D.L.C.)

25783 (COO-1198-238) THERMAL CONDUCTIVITY OF NaCl CONTAINING POINT DEFECTS. Ronald Caldwell and Miles V. Klein (Illinois Univ., Urbana. Dept. of Physics). [1963]. Contract AT(11-1)-1198. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effects of point defects on the host lattice of NaCl were studied by measuring the thermal conductivity of NaCl with and without doping by AgCl, RbCl, NaI, NaBr, and NaF. The pertinent properties of the doping ions are tabulated and discussed briefly with respect to phonon scattering. (D.L.C.)

25784 (LA-DC-7018) COLONY DEVELOPMENT OF A POLYMORPHIC HYDROID AS A PROBLEM IN PATTERN FORMATION. Maxwell H. Braverman (Carnegie Inst. of Tech., Pittsburgh, Pa.) and Robert G. Schrandt (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 60p. (CONF-650310-1). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

From Symposium on the Evolution of the Cnidaria, London.

Podocoryne carnea is a polymorphic, colonial, marine hydroid, normally appearing on a snail shell inhibited by a hermit crab. The various hydroid persons constituting a colony include the nutritive, the sexual, and the spiral zooids. These are connected at their bases by a branching stolen network. Podocoryne bears free-swimming medusae and is dioeacious. Results are reported from an attempt to simulate on an electronic computer the development of Podocoryne carnea as a colony is formed by a single hydranth placed on a microscope slide. The computer generates a relatively complex pattern as a mathematical model of the growing system by iteration of a set of simple rules of growth. The model consists of a connected network of points in a two-dimensional net. Its growth can be followed generation by generation and selected parameters of the generated pattern compared to those of real colonies. The ability of simple recursive rules to generate complex patterns suggests the possibility that genetic instructions of developing systems may, in part, be of a similar nature. (C.H.)

25785 (PNE-420) TERRESTRIAL MAMMALS INVESTIGATION, OGOTORUK CREEK–CAPE THOMPSON AND VICINITY. PART A. GENERAL STUDIES AND SMALL MAMMAL BIOLOGY. Project Chariot—Final Report. William O. Pruitt, Jr. (Alaska Univ., College. Dept. of Biological Sciences). Jan. 1962. Contract AT(04-3)-310. 157p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

An ecological study of terrestrial mammals of the Ogotoruk Valley and Cape Thompson area of Alaska, was made during 1959, 1960, and 1961. Emphasis was placed on the adaptations of small mammals to ecological stress, either natural, seasonal, or man-made; and the role of caribou in the region, with emphasis on migratory movements and population dynamics. The ecological relations of mammals in the terrestrial food chain were investigated. The studies were conducted as part of an investigation to establish data on the ecology of the Project Chariot site. (C.H.)

25786 (PNE-421) TERRESTRIAL MAMMALS INVESTIGATION, OGOTORUK CREEK–CAPE THOMPSON AND VICINITY. PART B. ECOLOGY OF THE ARCTIC GROUND SQUIRREL CITELLUS PARRYI. Project Chariot—Final Report. Ernest A. Carl (Alaska Univ., College. Dept. of Biological Sciences). June 1962. Contract AT(04-3)-310. 92p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Data are reported from an ecological study of the arctic ground squirrel, Citellus parryi, of the Ogotoruk Creek region of the Cape Thompson, Alaska, area made in 1960 and 1961. (C.H.)

25787 (PNE-422) HUMAN ECOLOGY INVESTIGATIONS, KIVALINA, ALASKA. Progress Report. (Alaska Univ., College). Dec. 1959. Contract [AT(04-3)-310]. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Eskimo village of Kivalina is situated on the northwestern coast of Alaska approximately 40 miles southeast of Cape Thompson. The population includes 145 persons, with 7 students away from home and 4 residents in hospitals in Dec. 1959. A survey was made of the extent of local dependence upon specific types of available food resources in an effort to determine the effects of Project Chariot on the economy of the village. (C.H.)

25788 (PNE-423) HUMAN ECOLOGY INVESTIGATIONS, KIVALINA, ALASKA. Phase II, Interim Final Report. Doris J. Saario (Alaska Univ., College). June 1960. Contract [AT(04-3)-310]. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The possible effects of Project Chariot on residents of the village of Kivalina, 40 miles southeast of the Cape Thompson project site, were investigated. The social structure and economic condition of the village were studied. It was concluded that the people of Kivalina are extremely dependent upon their natural resources for food and fuel. (C.H.)

25789 (PNE-424) HUMAN ECOLOGICAL INVESTIGATIONS AT KIVALINA, ALASKA. Progress Report, Phase III. Doris J. Saario (Alaska Univ., College. Dept. of Biological Sciences). Mar. 1961. Contract AT(04-3)-310. 28p. Project CHARIOT. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented from a survey on sources of animal food and food consumption by residents of Kivalina, near Cape Thompson, Alaska. The primary purpose of the survey was to determine the degree of dependence of the people of the village on natural resources which they hunt and harvest and the possible effects of Project Chariot on life in the village. It is pointed out that the community is largely dependent upon its natural resources and these must be obtained when and where they occur. Thus the activities of the village will be geared to when and where the fish, caribou, seal, and ugruk occur and the extent to which these resources are needed at the time. The occurrence of these species is dependent upon factors in their respective environments. It was concluded that only general predictions could be made as to when and where major activities of the village population will occur. (C.H.)

25790 (PNE-425) HUMAN ECOLOGICAL INVESTIGATIONS AT KIVALINA, ALASKA. Final Report. Doris J. Saario (Alaska Univ., College). Dec. 1962. Contract AT(04-3)-310. 129p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A survey was made of the natural resources, social structure, and ecological relations of the village of Kivalina in the Cape Thompson area of Alaska. The study was made during 1959, 1960, and 1961, as part of a survey of the site of Project Chariot, one phase of Plowshare Project, concerned with a proposed underground nuclear detonation. The objective of the study was to determine the extent to which the local population was dependent on their natural resources in an attempt to evaluate the changes to be expected as a result of the explosion. (C.H.)

25791 (PNE-426) SEA CLIFF BIRDS, CAPE THOMPSON AND VICINITY. Progress Report. L. G. Swartz

(Alaska Univ., College). Dec. 1, 1959. Contract [AT(04-3)-310]. 48p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An ecological study was made in 1959 on the sea-cliff birds of the Cape Thompson, Alaska, vicinity. The basic structure of the ecosystem was tentatively established and figures on biomass and the flow of energy and material are presented. The food intake from the ocean during the period of maximum feeding of the young birds was calculated to be about 28,000 kilograms per day. It is pointed out that all of this food would be potentially subject to radioactive contamination from Project Chariot. (C.H.)

25792 (PNE-427) SEA CLIFF BIRDS PROJECT. Phase II, Interim Final Report. L. Gerard Swartz (Alaska Univ., College). June 1960. Contract [AT(04-3)-310]. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Data are presented from an ecological study of the sea-cliff birds of Cape Thompson, Alaska, area. The possible effect of Project Chariot on bird populations was considered. (C.H.)

25793 (PNE-428) INVESTIGATIONS OF SEA-CLIFF BIRDS, CAPE THOMPSON, ALASKA. Progress Letter. L. G. Swartz and G. W. Cox (Alaska Univ., College). Sept. 1960. Contract [AT(04-3)-310]. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are presented on the breeding biology and ecology of sea-cliff birds of the Cape Thompson, Alaska, area. The possible effects of Project Chariot on bird populations was considered. (C.H.)

25794 (PNE-429) INVESTIGATIONS OF SEA-CLIFF BIRDS, CAPE THOMPSON, ALASKA. Project Chariot—Phase III, Progress Report. L. G. Swartz and G. W. Cox (Alaska Univ., College. Dept. of Biological Sciences). Dec. 1960. Contract [AT(04-3)-310]. 81p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Data on the breeding, biology, and ecology of sea-cliff birds of the Cape Thompson, Alaska, area were compiled in 1960. The possible effect of Project Chariot on bird populations was considered. (C.H.)

25795 (PNE-439) OGOTORUK CREEK BOTANICAL INVESTIGATIONS, CAPE THOMPSON, ALASKA. CYTOTAXONOMIC INVESTIGATIONS OF THE OGOTORUK CREEK–CAPE THOMPSON VASCULAR FLORA. Project Chariot—Progress Report. Albert W. Johnson and John G. Packer (Alaska Univ., College. Dept. of Biological Sciences). June 1963. Contract AT(04-3)-310. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A survey was made on the vascular flora of the Ogotoruk Creek area, Cape Thompson, Alaska. Data are summarized from studies made during the summer of 1959, 1960, and 1961. The work was performed as a part of the bio-environmental investigations of the Project Chariot site. (C.H.)

25796 (PNE-445) HANFORD PRELIMINARY EVALUATION REPORT OF PROJECT CHARIOT STUDIES, DECEMBER 1959. J. J. Davis, W. C. Hanson, and D. G. Watson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [1959]. Contract AT(45-1)-1350. 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Ecological studies in the Chariot environmental program included a limnological investigation, radioelement analyses in fresh-water and terrestrial ecosystems, and a study of the terrestrial invertebrates. The results of these studies in 1959 are given and discussed. (D.L.C.)

25797 (PNE-446) PROJECT CHARIOT ENVIRONMENTAL PROGRAM PHASE II INTERIM FINAL REPORT. HANFORD PHASE II REPORT OF PROJECT CHARIOT STUDIES, 1959. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 31, 1960. Contract AT(45-1)-1350. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

As part of the Chariot environmental program, the following studies were carried out: limnology of streams and inland ponds, ecology of terrestrial invertebrates, and radioecology of the terrestrial and fresh-water communities. A summary is presented of the results of these studies completed by June 1, 1960. (D.L.C.)

25798 (PNE-447) HANFORD PRELIMINARY EVALUATION REPORT OF PROJECT CHARIOT STUDIES, 1960. PROJECT CHARIOT ENVIRONMENTAL PROGRAM PHASE III PRELIMINARY REPORT. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 31, 1960. Contract AT(45-1)-1350. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Field studies were carried out on the structure and productivity of freshwater and terrestrial ecosystems from the environs of the Chariot test site prior to the harbor excavating detonations. The studies included limnological studies of streams and inland ponds, ecology of terrestrial invertebrates, and radioecology. The results are discussed. (D.L.C.)

25799 (PNE-448) HANFORD PROGRESS REPORT OF PROJECT CHARIOT STUDIES, 1961. J. J. Davis, D. G. Watson, and W. C. Hanson (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are tabulated for the contents of gamma-emitting radioelements in plants and animals of the Cape Thompson region during 1960. Precipitation, surface water, and soils are also included, and the radioelements include ^{54}Mn, ^{65}Zn, ^{95}Zr-^{95}Nb, ^{106}Ru-^{106}Rh, ^{137}Cs, ^{144}Ce-^{144}Pr. (D.L.C.)

25800 (PNE-450) PHASE III. PRELIMINARY REPORT ON SOIL CLASSIFICATION MAPPING AND ANALYSES AND SOIL MOVEMENT STUDIES. PROJECT CHARIOT ENVIRONMENTAL PROGRAM. J. H. Petro, H. R. Finney, K. R. Everett, and N. Holowaychuk (Ohio Agricultural Experiment Station, Wooster). Jan. 1961. Contract AT(11-1)-414. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A preliminary survey of soil types was made in preparation for Project Chariot. A tentative classification of soils of the Cape Thompson, Alaska, area is presented. A preliminary map of the soils was prepared by assembling air photo field sheet prints in an uncorrected mosaic. In addition to showing the Great Soil Group classification the field mapping units also show the kind of parent material, the ground pattern, the texture of the soil, the slope gradient, and proportion of bare soil surface resulting from congeliturbation. Results are included from soil movement investigations and chemical and physical analyses of selected profiles. (C.H.)

25801 (PNE-455) OCEANOGRAPHIC SURVEY OF THE EASTERN CHUKCHI SEA. Progress Report as of December 1, 1959. Brown Bear Cruise No. 236, August 1 to September 2, 1959. Richard H. Fleming, et al. (Washington Univ., Seattle. Dept. of Oceanography). Contract Nonr-477(10). 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Work during the past two months has been devoted to refining the field data, to the preparation of data compilations, and to examination of the biological material. The results obtained to date do not materially alter the general conclusions presented in the preliminary report. Data reports on the physical and chemical observations will be completed in the near future. Study of the geological and biological material will continue. (auth)

25802 (PNE-458) PRELIMINARY INVESTIGATIONS OF THE MARINE GEOLOGY OF THE SOUTHEASTERN CHUKCHI SEA. Technical Report No. 68. Brown Bear Cruise No. 236, August 1 to September 2, 1959. Joe S. Creager and Dean A. McManus (Washington Univ., Seattle. Dept. of Oceanography). May 1961. Contract Nonr-477(10). 51p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

As part of the oceanographic survey of southeastern Chukchi Sea for the Chariot environmental program, a marine geological study was conducted on the offshore waters. The bathymetric and geologic results were based on sounding data, surface grab samples, and short gravity cores. Sediments, heavy minerals, foraminifera, calcium carbonate, and organic carbon were studied. (D.L.C.)

25803 (PNE-459) PHYSICAL AND CHEMICAL DATA FOR THE EASTERN CHUKCHI AND NORTHERN BERING

SEAS. Brown Bear Cruise 236–August 1 to September 1, 1959. Brown Bear Cruise 268–July 26 to August 28, 1960. Technical Report No. 69. Richard H. Fleming, et al. (Washington Univ., Seattle. Dept. of Oceanography). Aug. 1961. 165p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Two Arctic cruises were made in 1959 and 1960 as part of the Chariot environmental program. The data taken include current measurements, geologic sampling, temperature, salinity, dissolved oxygen, inorganic phosphate, silicate, and bathythermographic data. (D.L.C.)

25804 (PNE-460) RECOVERY OF DRIFT BOTTLES RELEASED IN THE SOUTHEASTERN CHUKCHI SEA AND NORTHERN BERING SEA. Technical Report No. 70. Brown Bear Cruise 268, July 26 to August 28, 1960. Richard H. Fleming and Diane Heggarty (Washington Univ., Seattle. Dept. of Oceanography). Feb. 1962. Contract Nonr-477(10). 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

During August 1960, a total of 1653 drift bottles was released in the northern Bering and southeastern Chukchi Seas. During October and November 1960, 200 additional releases were made. Prior to 1 December 1960, a total of 129 recoveries was reported from the releases made in August. During the summer and fall of 1961, 34 additional recoveries were reported, 33 from the summer stations and one from the fall releases. The recoveries confirm the general northward transport of water in the area. Virtually all recoveries along the Alaskan coast of bottles released in the Chukchi Sea were from stations located near the coast. During 1961, six recoveries were reported from the USSR, one from Wrangel Island and the others from the Siberian coast. (auth)

25805 (PNE-461) PROGRESS REPORT OF THE LABORATORY OF RADIATION BIOLOGY, UNIVERSITY OF WASHINGTON. (Washington Univ., Seattle. Lab. of Radiation Biology). Oct. 1, 1959. Contract AT(45-1)-540. 31p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Results are reported from a 1959 survey of radioactivity in marine organisms and sediments of Chukchi Sea, near Cape Thompson, Alaska. No commercial quantities of economically important invertebrates or salmon were found. Naturally occurring Ra, Th, and U accounted for practically all of the radioactivity in the mud and biological samples counted. (C.H.)

25806 (PNE-462) CHARIOT PROJECT, PHASE II. Preliminary Evaluation Report. (Washington Univ., Seattle. Lab. of Radiation Biology). Dec. 1, 1959. Contract AT(45-1)-540. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

As part of the Chariot environmental program, the following was carried out: organization of the marine program (oceanographic and marine biological studies), radiological analyses of marine samples, preparation of lists of the fishes and marine invertebrates of the eastern Chukchi Sea, and salmon stream surveys. (D.L.C.)

25807 (PNE-463) CHARIOT PROJECT, PHASE II, JUNE 1960. Interim Final Report. (Washington Univ., Seattle. Lab. of Radiation Biology). June 1, 1960. Contract AT(45-1)-540. 97p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The marine studies in the Chariot environmental program included the organization of the marine program, radiological analyses of marine samples, preparation of lists of the fishes and marine invertebrates of the eastern Chukchi Sea, and a survey of salmon streams. The results are discussed in detail. (D.L.C.)

25808 (PNE-464) THE SALMON RESOURCE IN THE VICINITY OF THE CHARIOT SITE IN 1960. Howard D. Smith (Washington Univ., Seattle. Lab. of Radiation Biology). Dec. 30, 1960. Contract AT(45-1)-540. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

As part of the Chariot environmental studies program, an evaluation was made of the salmon runs in the vicinity of Cape Thompson, Alaska, from July 15 to August 31, 1960. The numbers, species, distribution, and timing of the salmon runs were determined. The data are summarized in three sections: stream surveys in the vicinity of the site, other stream surveys, and gill net catches in the Chukchi Sea. (D.L.C.)

25809 (PNE-475) MICROCLIMATOLOGY OF OGOTORUK VALLEY. Preliminary Report No. 1. P. W. Allen, I. Van der Hoven, and R. O. Weedfall (Weather Bureau Research Station, Las Vegas, Nev.). Dec. 15, 1960. Project Chariot. 94p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

A study is being conducted of the microclimate of the Ogotoruk Valley near Cape Thompson, Alaska. Weather data collected since August 1959 are tabulated. The instrumentation used is described. Wind, precipitation, temperature, cloudiness and relative humidity, and solar radiation are discussed. (D.L.C.)

25810 (PNE-476) MICROCLIMATOLOGY OF OGOTORUK VALLEY. Interim Report No. 2. Robert O. Weedfall (Weather Bureau Research Station, Las Vegas, Nev.). June 15, 1961. Project Chariot. 29p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

Micrometeorological observations in the Alaska valley were made from October 1960 through April 1961, as a part of the Chariot environmental study program. These observations include surface wind, sea ice, precipitation, and temperature. (D.L.C.)

25811 (PNE-478) MICROCLIMATOLOGY OF OGOTORUK VALLEY, ALASKA. Final Report. P. W. Allen and R. O. Weedfall (Weather Bureau Research Station, Las Vegas, Nev.). Apr. 1962. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The unique topographic features of Ogotoruk Valley result in cold-air channeling from the northeast, around the western end of the Brooks Range. Depressed precipitation totals and lower temperatures result. The frequent northerly winter gales also prevent heavy snow accumulation. The cool waters of the Arctic have an important climatic effect and depress summer warming of the air and soil and thus help keep the level of permafrost at shallow depths, especially in the lower parts of the Valley, away from the rocky hill-tops. (auth)

25812 (PNE-479) A PRELIMINARY REPORT ON MARINE INVESTIGATIONS OF THE CHUKCHI SEA, AUGUST 1959. Dayton L. Alverson, Norman J. Wilimovsky, and Ford Wilke (Bureau of Commercial Fisheries, Seattle, Wash. Exploratory Fishing and Gear Research Base). June 17, 1960. 47p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

As part of the Chariot environmental program, marine ecological studies were carried out in the eastern Chukchi Sea region. The studies included field investigations which were conducted on the ship John N. Cobb from August 5 to 31, 1959. Observations on fish, invertebrate fauna, birds, and mammals are reported. (D.L.C.)

25813 (SC-R-64-1338) THERP. A. D. Swain (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract [AT(29-1)-789]. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A point-estimate model for ascertaining the quantitative effects of human behavior upon man-machine system reliability is discussed. Some recent applications of the model and some of the research needs for improving this and other models to quantify human performance are described. (auth)

25814 (SC-RR-65-137) PROCEDURE FOR THE ANALYSIS OF SEMICONDUCTOR FAILURES. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 11p. Dep.; $1.00(cy), 1(mn) CFSTI.

A procedure is given for an efficient semiconductor failure analysis program. Methods of electrical testing, visual inspection, mounting, polishing, and etching are described. Examples of results obtained are given along with discussions of the problems encountered in the complete analysis. (auth)

25815 (SC-TM-64-1735) PRODUCING SMALL-DIAMETER HOLES WITH A LENGTH-TO-DIAMETER RATIO GREATER THAN 100. J. A. Rohrer (Sandia Corp.,

Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Work is described in which small-diameter holes of almost unlimited length can be produced by lapping. The technique used was to draw a 0.003-inch nickel wire between two compressively loaded lucite blocks. The wire was charged with a suitable lapping compound and drawn slowly, at a uniform rate, between the blocks. As a channel was cut into them, the compressive loading adequately adjusted the floating blocks so that further cutting was effected. Finally, when the two interfaces were in close contact, no further cutting took place. The capillary groove was then found: (1) to be straight; (2) to have a fine, uniform surface; and (3) to have a uniform radius for the full length. The blocks were then thoroughly cleaned and glued together with a lucite solvent. (auth)

25816 (SC-TM-65-49) SUN SENSOR METHOD OF OBTAINING SPIN AND CONING INFORMATION FOR SMALL ROCKETS. Lee M. Bossart (Sandia Corp., Albuquerque, N. Mex.). Mar. 1965. Contract AT(29-1)-789. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

This memorandum describes a pinhole camera technique for measuring the spin and coning parameters of small rockets. The results obtained using this technique on a Nike-Tomahawk flight are also given and analyzed. (auth)

25817 (UCLA-12-553) ECOLOGY OF THE NEVADA TEST SITE. I. GEOGRAPHIC AND ECOLOGIC DISTRIBUTIONS OF THE VASCULAR FLORA (ANNOTATED CHECKLIST). Janice C. Beatley (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Apr. 1965. Contract AT(04-1)-Gen-12. 67p. Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

A checklist of vascular plants of the Nevada Test Site is presented for use in studies of plant ecology. Data on the occurrence and distribution of plant species are included. Collections were made from both undisturbed and disturbed sites. (C.H.)

25818 APPARATUS FOR SOLVENT-ISOSTATIC PRESSING. Paul B. Archibald. (to U. S. Atomic Energy Commission). U. S. Patent 3,177,554. Apr. 13, 1965.

An apparatus was developed for producing compated bodies from a powdered material. The elements of the apparatus are a deformable container adapted to contain the powdered material, a rigid container removably connected to the deformable container, a perforated partition disposed between the rigid and deformable containers, a solvent in which the powdered material is at least partially soluble disposed within the deformable container in contact with the powdered material, and means for isostatically compressing the deformable container. (AEC)

25819 BINARY MEMORY DEVICE EMPLOYING FLIP-FLOP THAT IS CONTROLLED BY IN-PHASE DRIVERS. H. Guckel (to U. S. Atomic Energy Commission). U. S. Patent 3,181,004. Apr. 27, 1965.

A high-speed flip-flop-gate complex using transistors is described. The feedback loop gain is reduced during the gate-in process and restored to normal after the flip-flop is set. In-phase driver signals produced by the gate-in pulse are used to drive diode clamps connected to each transistor base to control the loop gain. (AEC)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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SUBJECT INDEX

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The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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458266	19-24673	See NP-14953
603247	19-25552	See AL-TDR-64-155
606871	19-25555	See RADC-TDR-64-244
607090	19-25551	See AFCRL-64-672
607091	19-25550	$4.00(CFSTI)
607241	19-24956	See WADD-TR-61-72(Vol.VII)(Suppl.)
607400	19-25247	See AFCRL-64-409
612759	19-24976	$2.00(CFSTI)
AECD-EP-	**(Pakistani)**	
1	19-25089	Dep.(mn)
AECL-	**(Canadian)**	
1580	19-25782	Dep.(mn); $1.50(AECL)
2136	19-24397	Dep.; $0.50(AECL)
2235	19-24744	Dep.(mn); $0.50(AECL)
2237	19-24840	See CRGP-1214
AED-C-	**(German)**	
01-08	19-25615	Dep.(mn)
AERE-M-	**(British)**	
1387	19-24539	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
1518	19-25758	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
AERE-R-	**(British)**	
4435	19-25064	J. Nucl. Mater., 14: 179-86(1964)
4437	19-25022	J. Nucl. Mater., 14: 203-4(1964)
4443	19-25063	J. Nucl. Mater., 14: 135-40(1964)
4447	19-24962	J. Nucl. Mater., 14: 285-93(1964)
4853	19-25620	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
4859	19-24398	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
AFCRL-	**(Non-AEC)**	
64-409	19-25247	$5.00(CFSTI)
64-672	19-25551	$3.00(CFSTI)
AFML-TR-	**(Non-AEC)**	
65-2(Pt.I,Vol.I)	19-24977	
Al-Trans-		
84	19-25625	Dep.(mn); $1.60(fs), $0.80(mf) JCL
AL-TDR-	**(Non-AEC)**	
64-155	19-25552	CFSTI
ANL-		
6845	19-25702	Dep.; $3.00(CFSTI)
6901	19-24602	Dep.; $3.00(cy), 2(mn) CFSTI
6998	19-24587	Dep.; $1.00(cy), 1(mn) CFSTI
6999	19-24603	Dep.; $1.00(cy), 2(mn) CFSTI
ANS-		
100(p.65-67)	19-25705	See LA-DC-6669
ARF-	**(Misc.)**	
1193-17	19-25468	Dep.(mn); $3.00(cy), 2(mn) CFSTI
AROD-	**(Misc.)**	
2884.3	19-24978	
2884.4	19-24979	
ASD-TDR-	**(Non-AEC)**	
63-829(Pt.I)	19-24945	
63-829(Pt.II)	19-24946	
AWRE-O-	**(British)**	
4/65	19-24238	Dep.(mn); $1.20(BIS); 6s. 0d. (HMSO)
14/65	19-24395	Dep.(mn); $1.40(BIS), 7s. (HMSO)
BMI-	**(Misc.)**	
1720	19-25720	Dep.; $1.00(cy), 1(mn) CFSTI
BMI-X-		
10120	19-24880	Dep.(mn); $2.00(cy), 1(mn) CFSTI
BNL-		
898	19-24259	Dep.; $1.00(cy), 1(mn) CFSTI
7739	19-24914	p.221-46 of "Progress in Nuclear Techniques and Instrumentation. Vol. I." Amsterdam, North-Holland Publishing Co., 1965.
8031	19-24239	Dep.(mn); $1.00(cy), 1(mn) CFSTI
8053	19-24240	Dep.(mn); $2.00(cy), 1(mn) CFSTI
8414	19-24346	Radiation Res., 24: 650-6(1965)
8535	19-24334	Radiation Botany, 5: 129-41(1965)
8744	19-25351	Phys. Rev., 138: B913-20(1965)
8972	19-25090	Dep.(mn); $1.00(cy), 1(mn) CFSTI
9160	19-25043	Dep.(mn); $1.00(cy), 1(mn) CFSTI
BNWL-		
6	19-24915	Dep.; $2.00(cy), 1(mn) CFSTI
45	19-24904	Dep.; $1.00(cy), 1(mn) CFSTI
46	19-24604	Dep.(mn); $1.00(cy), 1(mn) CFSTI
51	19-24902	Dep.; $2.00(cy), 1(mn) CFSTI
66	19-24640	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CALT-		
68-29	19-25504	Nuovo Cimento (10), 37: 337-41(1965)
CAPE-		
917	19-24869	EM
983	19-25115	EM
1084	19-24658	EM
1124	19-24827	EM
1159	19-24828	EM
1163	19-24927	EM
1171	19-24657	EM
1196	19-24475	EM
CAR-		
882-9	19-25469	Dep.(mn); $3.00(cy), 2(mn) CFSTI
CEA-R-	**(French)**	
2629	19-24700	Dep.(mn)
CEAL-		
1020	19-25091	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CEND-	**(Misc.)**	
2936-222	19-25044	Dep.(mn); $5.00(cy), 4(mn) CFSTI
CLM-P-	**(British)**	
56	19-25564	Astrophys. J., 141: 343-53(1965)
CLOR-	**(Polish)**	
32	19-24701	Dep.
CNAEM-	**(Turkish)**	
23	19-24480	Dep.(mn)
CNLM-	**(Misc.)**	
5351	19-24931	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5537	19-24652	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CONF-281-	**19-24924**	**(International Conference on Beryllium Oxides, Sydney, Oct. 1963) Proceedings**
CONF-498-	**(Geological Society of America 1963 Annual Meeting, New York, Nov. 1963)**	
8	19-24738	ORINS. Gmelin, AED-CONF-63-264-11
9	19-24739	ORINS. Gmelin, AED-CONF-63-264-9
CONF-540-	**(American Society for Metals, Western Metal and Tool Conference, Los Angeles, Mar. 1964)**	
5	19-24964	ORINS
CONF-555-	**(International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964)**	
17	19-24747	See ORNL-TM-1049

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CONF-566–		(8th International Congress of Soil Science, Bucharest, Aug. 31–Sept. 9, 1964)
2	19-24625	Soil Sci. Am. Proc., 29: 25-8(1965)
CONF-603–		(Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June–July 1964)
10	19-24695	ORINS. Gmelin, AED-CONF-64-109-11
CONF-649–		(12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964)
27	19-24478	ORINS. Gmelin, AED-CONF-64-093-38
CONF-651–		(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)
58	19-25452	ORINS. Gmelin, AED-CONF-64-140-92
72	19-25453	ORINS. Gmelin, AED-CONF-64-140-80
82	19-25413	ORINS. Gmelin, AED-CONF-64-140-99
CONF-654–		(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964) Proceedings
44	19-25465	ORINS. Gmelin, AED-CONF-64-219-22
45	19-24727	ORINS. Gmelin, AED-CONF-64-219-23
88	19-25256	ORINS. Gmelin, AED-CONF-64-219-101
CONF-717–		(CNRS Meeting on Graft of Allogenic Hematopoietic Cells, Paris, Sept. 7–9, 1964)
19	19-24226	See ORNL-P-1111
CONF-720–		(2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Oct. 1964)
13	19-25547	ORINS. Gmelin, AED-CONF-64-190-22
23	19-25618	ORINS. Gmelin, AED-CONF-64-190-30
CONF-721–		(8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 6–8, 1964)
14	19-25047	See NAA-SR-Memo-10509
CONF-727–		(10th Annual Bioassay and Analytical Chemistry Meeting, Cincinnati, Oct. 1964)
5	19-24844	See LA-DC-6637
CONF-758–		(American Physical Society Meeting, New York, Jan. 22–25, 1965)
5	19-25386	ORINS. Gmelin, AED-CONF-65-003-2
7	19-25609	ORINS. Gmelin, AED-CONF-65-003-4
9	19-25181	ORINS. Gmelin, AED-CONF-65-003-32
11	19-25546	ORINS. Gmelin, AED-CONF-65-003-28
13	19-25387	ORINS. Gmelin, AED-CONF-65-003-26
14	19-25548	ORINS. Gmelin, AED-CONF-65-003-16
15	19-25549	ORINS. Gmelin, AED-CONF-65-003-15
16	19-25388	ORINS. Gmelin, AED-CONF-65-003-20
CONF-769–		(Conference on Electrical Insulation, Cleveland, Oct. 11–14, 1964)
10	19-24584	ORINS. Gmelin, AED-CONF-64-199-3
CONF-799–		(11th Annual Nuclear Science Symposium, Philadelphia, Oct. 28–30, 1964)
12	19-24548	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-225-18
15	19-24870	ORINS. Gmelin, AED-CONF-64-225-27
CONF-610801	19-25085	(United Nations Conference on New Sources of Energy, Rome, Aug. 21–31, 1961) Proceedings
CONF-611202	19-24756	(Seminar on Agricultural and Public Health Aspects of Radioactive Contamination in Normal and Emergency Situations, Scheveningen, the Netherlands, Dec. 11–15, 1961) Proceedings
CONF-620403–		(10th National Conference on Electromagnetic Relays, Stillwater, Okla., Apr. 24–26, 1962)
1	19-24647	ORINS
CONF-621002	19-24745	(International Symposium on Radioactive Contamination of Workers, Munich, Oct. 24–26, 1962) Proceedings
CONF-630908	19-24714	(Symposium on Nuclear Detonations and Marine Radioactivity, Kjeller, Norway, Sept. 16–20, 1963) Proceedings
CONF-630909	19-24648	(Non-Classical Shell Problems Symposium, Warsaw, Sept. 2–5, 1963) Proceedings
CONF-640606–		(American Physical Society Summer Meeting, Denver, Colo., June 25–27, 1964)
2	19-25263	See IS-987
CONF-640808–		(European Congress on Cardiology, Prague, Aug. 17–22, 1964)
1	19-24380	See EUR-1889.f
CONF-640810–		(Conference on Nuclear Marine Propulsion, Blacksburg, Va., Aug. 10–13, 1964)
2	19-25756	ORINS. Gmelin, AED-CONF-64-228-8
3	19-25757	ORINS. Gmelin, AED-CONF-64-228-1
7	19-25755	ORINS. Gmelin, AED-CONF-64-228-7
9	19-25739	ORINS. Gmelin, AED-CONF-64-228-10
CONF-640903–		(American Vacuum Society Symposium, Chicago, Sept. 30–Oct. 2, 1964)
12	19-24696	ORINS. Gmelin, AED-CONF-64-171-35
14	19-24476	ORINS. Gmelin, AED-CONF-64-171-40
CONF-641004–		(American Physical Society, Chicago, Oct. 23–24, 1964)
6	19-25244	ORINS. Gmelin, AED-CONF-64-220-20
CONF-641009–		(Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y., Oct. 5–7, 1964)
14	19-25754	ORINS. Gmelin, AED-CONF-64-193-13
CONF-641017–		(Symposium on Low Energy X and Gamma Sources and Applications, Chicago, Oct. 20–21, 1964)
6	19-24477	ORINS. Gmelin, AED-CONF-64-221-9
8	19-24690	ORINS. Gmelin, AED-CONF-64-221-12
9	19-24901	ORINS. Gmelin, AED-CONF-64-221-13
CONF-641022–		(Optical Society of America, Annual Meeting, New York, Oct. 6–9, 1964)
1	19-25612	ORINS. Gmelin, AED-CONF-64-227-1
CONF-641108–		(American Physical Society, New York, Nov. 4–8, 1964)
15	19-25605	ORINS. Gmelin, AED-CONF-64-196-43
17	19-25604	ORINS. Gmelin, AED-CONF-64-196-41
20	19-25182	ORINS. Gmelin, AED-CONF-64-196-53
31	19-25606	ORINS. Gmelin, AED-CONF-64-196-33
32	19-25603	ORINS. Gmelin, AED-CONF-64-196-32
35	19-25608	ORINS. Gmelin, AED-CONF-64-196-38
38	19-25607	ORINS. Gmelin, AED-CONF-64-196-37
43	19-25611	ORINS. Gmelin, AED-CONF-64-196-62
44	19-25610	ORINS. Gmelin, AED-CONF-64-196-57
CONF-641114–		(American Physical Society, Southeastern Section, Chattanooga, Tenn., Nov. 1964)
3	19-24585	ORINS. Gmelin, AED-CONF-64-194-9
CONF-641118–		(Pittsburgh Diffraction Conference, Pittsburgh, Nov. 4–6, 1964)
1	19-25041	ORINS. Gmelin, AED-CONF-64-229-3
CONF-641119–		(American Physical Society, Division of Fluid Dynamics, Pasadena, Calif., Nov. 23–25, 1964)
2	19-25613	ORINS. Gmelin, AED-CONF-64-237-1
3	19-25087	ORINS. Gmelin, AED-CONF-64-237-3
CONF-641201–		(American Institute of Chemical Engineers Annual Meeting, Boston, Dec. 6–10, 1964)
17	19-24532	ORINS. Gmelin, AED-CONF-64-235-14
CONF-641210–		(American Physical Society Meeting, Berkeley, Calif., Dec. 1964)
14	19-25145	ORINS. Gmelin, AED-CONF-64-236-13
16	19-25144	ORINS. Gmelin, AED-CONF-64-236-12
CONF-650103–		(International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.,

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	Jan. 11, 1965)	
7	19-24815	ORINS. Gmelin, AED-CONF-65-001-5
9	19-24816	ORINS. Gmelin, AED-CONF-65-001-11
10	19-24817	ORINS. Gmelin, AED-CONF-65-001-17
11	19-24814	ORINS. Gmelin, AED-CONF-65-001-18
CONF-650105–	**(Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York, Jan. 31–Feb. 5, 1965)**	
6	19-25257	ORINS. Gmelin, AED-CONF-65-002-6
CONF-650108–	**(AIAA 2nd Aerospace Sciences Meeting, New York, Jan. 25–27, 1965)**	
7	19-25258	ORINS
CONF-650203–	**(National AIME Meeting, Chicago, Feb. 14–18, 1965)**	
5	19-24630	ORINS. Gmelin, AED-CONF-65-005-3
CONF-650215–	**(American Society of Metals Western Metal Congress, Los Angeles, Feb. 22–26, 1965)**	
1	19-25040	ORINS
2	19-24965	ORINS
3	19-25039	ORINS
CONF-650216–	**(American Nuclear Society, Niagara Finger Lakes Section Meeting, Toronto, Feb. 12, 1965)**	
1	19-24586	ORINS. Gmelin, AED-CONF-65-009-1
CONF-650301–	**(Symposium on the Physics and Chemistry of Fission, Salzburg, Mar. 22–26, 1965)**	
15	19-25471	See JINR-P-2025
CONF-650306–	**(Particle Accelerator Conference, Washington, D. C., Mar. 10–12, 1965)**	
16	19-25090	See BNL-8972
25	19-25100	See UCRL-11801
26	19-25101	See UCRL-11812
37	19-25092	See LA-DC-6754
40	19-25093	See LA-DC-6779
51	19-25095	See ORNL-P-1133
53	19-25096	See ORNL-P-1135
54	19-25094	See ORNL-P-1131
55	19-25097	See ORNL-P-1137
57	19-25098	See ORNL-P-1148
CONF-650310–	**(Symposium on the Evolution of the Cnidaria, London, Mar. 3, 1965)**	
1	19-25784	See LA-DC-7018
CONF-650405–	**(International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19–22, 1965)**	
4	19-24407	See RFP-522
CONF-650407–	**(International Symposium on Fission Product Release and Transport Under Accident Conditions, Oak Ridge, Tenn., Apr. 1965)**	
1	19-24746	See ORNL-P-1182
CONF-650413–	**(Symposium on Neutron Dynamics and Control, Tucson, Ariz., Apr. 5–7, 1965)**	
1	19-25760	See LA-DC-6891
2	19-25748	See LA-DC-6837
CONF-650417–	**(American Nuclear Society, National Topical Meeting on Fast Reactor Technology, Detroit, Apr. 26–28, 1965)**	
1	19-25705	See LA-DC-6669
CONF-650503–	**(Experimental Stress Analysis Association, Denver, May 1965)**	
2	19-25624	See UCRL-11977
CONF-650504–	**(IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Germany, May 10–14, 1965)**	
3	19-25457	See RPI-328-28
6	19-25458	See RPI-328-33
CONF-650604–	**(International Symposium on Working Methods in High Activity Hot Labs., Grenoble, France, June 15–18, 1965)**	
3	19-24588	See ORNL-P-1154
CONF-650606–	**(EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels, June 10–11, 1965)**	
2	19-25728	See ORNL-TM-1111
3	19-25729	See ORNL-TM-1112
4	19-25706	See ORNL-TM-1115
5	19-25707	See ORNL-TM-1123
CONF-650607–	**(American Society of Mechanical Engineers, Berkeley, June 1965)**	
1	19-24991	See UCRL-12405
COO–		
264-219	19-25269	Ann. Phys. (N. Y.), 32: 201-17(1965)
264-221	19-25560	Am. J. Phys., 33: 319-22(1965)
264-226	19-25355	Phys. Rev., 138: B943-6(1965)
878-11	19-24340	Radiation Res., 24: 563-71(1965)
987-4	19-24980	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1170-3	19-24241	Dep.; $1.00(cy), 1(mn) CFSTI
1198-238	19-25783	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1213-26	19-24665	Dep.(mn); $5.00(cy), 3(mn) CFSTI
1296-1	19-24236	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1319-12	19-24932	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1319-15	19-24933	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1319-21	19-24934	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CRGP–	**(Canadian)**	
1214	19-24840	Dep.(mn); $1.00(AECL)
CU–	**(Misc.)**	
2660-16	19-24981	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CVNA–	**(Misc.)**	
220	19-25721	Dep.(mn); $2.00(cy), 1(mn) CFSTI
223	19-25722	Dep.(mn); $5.00(cy), 4(mn) CFSTI
DP–		
952	19-24605	Dep.; $1.00(cy), 1(mn) CFSTI
953	19-24818	Dep.; $1.00(cy), 1(mn) CFSTI
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EFINS–	**(Misc.)**	
64-53	19-25269	See COO-264-219
64-55	19-25560	See COO-264-221
ER–	**(Misc.)**	
7448	19-25749	See NP-15022(Vol.I)
7591	19-25049	See NP-15022(Vol.II)
7644	19-25750	See NP-15022(Vol.III)
7702	19-25048	See NP-14889
EUR–	**(European Atomic Energy Community)**	
1889.f	19-24380	Dep.(mn)
2151.f	19-24367	Dep.(mn)
2210	19-24745	
2272.n	19-24540	Dep.(mn)
2282.d	19-24541	Dep.(mn)
EURAEC–		
991	19-24396	See GNEC-320
1270	19-24982	Dep.(mn); $5.00(cy), 3(mn) CFSTI
1280	19-24947	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1295	19-24935	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1308	19-24936	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1346	19-24937	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1372	19-24666	See GEAP-4843
FZK–	**(Non-AEC)**	
208	19-24841	
GA–	**(Misc.)**	
4395	19-24881	
5036	19-25723	Dep.(mn); $3.00(cy), 2(mn) CFSTI
5283	19-25583	Proc. Natl. Acad. Sci. U. S., 53: 866-73(1965)
5314	19-25045	Dep.(mn); $3.00(cy), 2(mn) CFSTI
GAMD–	**(Misc.)**	

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5239	19-24641	Dep.(mn); $3.00(cy), 2(mn) CFSTI
GAT-T–		
1141	19-24481	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GEAP–	(Misc.)	
4756	19-24948	Dep.(mn); $3.00(cy), 2(mn) CFSTI
4843	19-24666	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GEMP–	(Misc.)	
334A	19-24916	Dep.; $6.00(cy), 4(mn) CFSTI
334C	19-25639	Dep.; $3.00(cy), 1(mn) CFSTI
GNEC–		
320	19-24396	Dep.(mn); $3.00(cy), 2(mn) CFSTI
HW–		
63084-RD	19-25703	Dep.(mn); $1.00(cy), 1(mn) CFSTI
63247	19-24842	Dep.(mn); $2.00(cy), 1(mn) CFSTI
71986	19-24606	Dep.(mn); $1.00(cy), 1(mn) CFSTI
74968	19-24607	Dep.(mn); $1.00(cy), 1(mn) CFSTI
75153	19-24608	Dep.(mn); $1.00(cy), 1(mn) CFSTI
76195	19-25704	Dep.(mn); $7.91(cy), 15(mn) CFSTI
76326	19-24819	Dep.(mn); $1.00(cy), 1(mn) CFSTI
77978	19-24609	Dep.(mn); $1.00(cy), 1(mn) CFSTI
77979	19-25771	Dep.(mn); $1.00(cy), 1(mn) CFSTI
78814	19-24399	Dep.(mn); $1.00(cy), 1(mn) CFSTI
81256-1	19-24905	Dep.(mn); $1.00(cy), 1(mn) CFSTI
81780	19-24689	Dep.(mn); $2.00(cy), 1(mn) CFSTI
82658	19-25724	Dep.(mn); $1.00(cy), 1(mn) CFSTI
83615	19-25046	Dep.; $3.00(cy), 2(mn) CFSTI
83896	19-25772	Dep.; $4.00(CFSTI)
84369	19-25634	Dep.; $3.00(cy), 2(mn) CFSTI
84577	19-25773	Dep.(mn); $3.00(cy), 2(mn) CFSTI
84603	19-25774	Dep.; $3.00(cy), 1(mn) CFSTI
IDO–		
14638	19-24610	Dep.; $0.75(cy), 1(mn) CFSTI
IITRI–	(Misc.)	
578P21-12	19-25640	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1184-16	19-25621	Dep.(mn); $1.00(cy), 1(mn) CFSTI
IMP-AEC–		
30	19-24504	J. Chem. Phys., 42: 3364-6(1965)
IS–		
818	19-24619	J. Inorg. Nucl. Chem., 27: 589-601(1965)
850	19-24508	J. Inorg. Nucl. Chem., 27: 583-7(1965)
858	19-24621	J. Inorg. Nucl. Chem., 27: 625-9(1965)
899	19-24622	J. Inorg. Nucl. Chem., 27: 631-40(1965)
903	19-24996	Acta Cryst., 18: 968-73(1965)
906	19-24620	J. Inorg. Nucl. Chem., 27: 603-23(1965)
987	19-25263	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-113-7
1048	19-25016	J. Less-Common Metals, 8: 289-98(1965)
1061	19-24482	Dep.; $4.00(cy), 3(mn) CFSTI
1068	19-25019	J. Less-Common Metals, 8: 352-3(1965)
1122	19-24483	Dep.; $3.00(cy), 2(mn) CFSTI
IS-T–		
9	19-24983	Dep.(mn); $3.00(cy), 2(mn) CFSTI
11	19-24484	Dep.(mn); $3.00(cy), 1(mn) CFSTI
JINR–	(Russian)	
P-2001	19-24485	Dep.(mn)
P-2025	19-25471	Dep.(mn)
JPRS–	(Non-AEC)	
29452	19-24227	$4.00(CFSTI)
29457	19-24243	$1.00(CFSTI)
29606	19-24264	$1.00(CFSTI)
KAPL–		
3088	19-24984	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KAPL-M–		
6174	19-24911	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6424	19-25472	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KR–	(Norwegian)	
91	19-24400	Dep.(mn)
92	19-24401	Dep.(mn)
LA–		
3200	19-24917	Dep.; $1.00(cy), 1(mn) CFSTI
3211	19-24667	Dep.; $2.00(cy), 1(mn) CFSTI
3217	19-24918	Dep.; $2.00(cy), 1(mn) CFSTI
3228	19-24843	Dep.; $2.00(cy), 1(mn) CFSTI
3232	19-24949	Dep.; $2.00(CFSTI)
3233	19-24985	Dep.; $2.00(CFSTI)
3245	19-24702	Dep.; $2.00(cy), 1(mn) CFSTI
3246	19-24668	Dep.; $2.00(cy), 1(mn) CFSTI
3252	19-24486	Dep.; $1.00(CFSTI)
3255	19-24950	Dep.; $1.00(cy), 1(mn) CFSTI
3258	19-24402	Dep.; $1.00(CFSTI)
3264	19-24669	Dep.; $2.00(cy), 1(mn) CFSTI
3289	19-25553	Dep.; $4.00(CFSTI)
LA-DC–		
6637	19-24844	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6669	19-25705	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6671	19-24959	Intern. J. Powder Met., 1: No. 2, 56-63(1965)
6754	19-25092	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6779	19-25093	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6837	19-25748	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6891	19-25760	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7018	19-25784	Dep.(mn); $3.00(cy), 2(mn) CFSTI
7024	19-25514	Phys. Letters, 16: 57-9(1965)
7108	19-24882	Dep.(mn); $3.00(cy), 2(mn) CFSTI
LA-tr–		
65-7	19-25072	Dep.(mn); $1.00(cy), 1(mn) CFSTI; $2.60(fs), $0.89(mf) JCL
LNF–	(Italian)	
65/10	19-25111	Nuovo Cimento (10), 37: 751-2(1965)
LYCEN–	(French)	
6416/1	19-25473	Dep.(mn)
MATT–		
292	19-24820	Dep.; $2.00(cy), 1(mn) CFSTI
314	19-25554	Dep.; $2.00(cy), 1(mn) CFSTI
ML–	(Misc.)	
63611	19-24242	See NP-14901
MLM–		
1220	19-24986	Dep.; $2.00(cy), 1(mn) CFSTI
1227	19-24611	Dep.(mn); $2.00(cy), 1(mn) CFSTI
MTI–	(Misc.)	
64TR7	19-24653	See NYO-3237-1
65TR8	19-24654	See NYO-3237-2
65TR9	19-24642	See NYO-3363-2
N–	(Misc.)	
64-19352	19-24260	See NASA-CR-53780
65-20794	19-25048	See NP-14889
65-20885	19-24957	See WANL-PR(P)-006
NAA-SR–		
8541	19-24951	Dep.; $0.75(cy), 1(mn) CFSTI
9827	19-24670	Dep.; $1.00(cy), 1(mn) CFSTI
10284	19-24883	Dep.; $4.00(cy), 3(mn) CFSTI
10511	19-24821	Dep.; $2.00(cy), 1(mn) CFSTI
10899	19-25454	Dep.; $3.00(cy), 1(mn) CFSTI
NAA-SR-Memo–		
9977	19-25686	Dep.(mn); $3.00(cy), 2(mn) CFSTI
10509	19-25047	Dep.(mn); $1.00(cy), 1(mn) CFSTI
10596	19-25725	Dep.(mn); $2.00(cy), 1(mn) CFSTI
10692	19-24912	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NASA-CR–	(Misc.)	
53780	19-24260	$3.60(CFSTI)
54301	19-24957	See WANL-PR(P)-006
57750	19-25048	See NP-14889

Report No.	Abstract No.	Availability
NASA-TN–	**(Misc.)**	
D-2280	19-24671	
D-2802	19-24672	$1.00(CFSTI)
NLCO–		
922	19-24919	Dep.; $2.00(cy), 1(mn) CFSTI
NMI–	**(Misc.)**	
2136	19-24920	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2523	19-24952	Dep.(mn); $2.00(cy), 1(mn) CFSTI
7262	19-24953	Dep.(mn); $2.00(cy), 2(mn) CFSTI
NNES–		
IV-12A	19-24921	Dep.(mn); $5.00(cy), 4(mn) CFSTI
NP–	**(AEC File No. for Non-AEC Reports)**	
14853	19-24542	
14889	19-25048	$3.00(cy), 1(mn) CFSTI
14901	19-24242	Dep.(mn)
14952	19-24403	
14953	19-24673	
14956	19-24728	
14963	19-24845	Dep.(mn)
14991	19-25411	
15007	19-25474	Dep.(mn)
15009	19-24692	$3.00(CFSTI)
15013	19-24703	Dep.(mn); $0.30(BIS), 1s. 9d. (HMSO)
15022(Vol.I)	19-25749	
15022(Vol.II)	19-25049	
15022(Vol.III)	19-25750	
15024	19-24938	
OPCC-MWP–	**(British)**	
(S)/P(63)19	19-25055	See TRG-Report-511
NUMEC–		
3432-7	19-25050	Dep.(mn); $4.00(cy), 3(mn) CFSTI
NYO–		
1480-14	19-24913	Dep.(mn); $7.00(cy), 6(mn) CFSTI
2262-86	19-25264	Dep.(mn); $3.00(cy), 2(mn) CFSTI
2722-1	19-25622	Dep.(mn); $4.00(cy), 3(mn) CFSTI
2784-7	19-24920	See NMI-2136
3008-1	19-24698	Dep.(mn); $2.00(cy), 2(mn) CFSTI
3237-1	19-24653	Dep.(mn); $3.00(cy), 1(mn) CFSTI
3237-2	19-24654	Dep.(mn); $4.00(cy), 2(mn) CFSTI
3363-2	19-24642	Dep.(mn); $2.00(cy), 2(mn) CFSTI
ORNL–		
3731	19-25726	Dep.; $7.00(cy), 6(mn) CFSTI
3784	19-24939	Dep.; $3.00(cy), 2(mn) CFSTI
3792	19-24906	Dep.; $3.00(cy), 2(mn) CFSTI
3804	19-24487	Dep.; $3.00(cy), 2(mn) CFSTI
ORNL-P–	**(Misc.)**	
187	19-24409	Anal. Chim. Acta, 32: 332-8(1965)
436	19-24440	J. Inorg. Nucl. Chem., 27: 1117-39(1965)
643	19-24290	Genetics, 51: 723-32(1965)
726	19-24513	J. Inorg. Nucl. Chem., 27: 1021-36(1965)
850	19-25013	J. Am. Ceram. Soc., 48: 216(1965)
1111	19-24226	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1128	19-25057	Appl. Phys. Letters, 6: 159-60(1965)
1131	19-25094	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1133	19-25095	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1135	19-25096	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1137	19-25097	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1148	19-25098	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1154	19-24588	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1182	19-24746	Dep.(mn); $1.00(cy), 1(mn) CFSTI
ORNL-TM–		
907	19-24612	Dep.(mn); $3.00(cy), 2(mn) CFSTI
973	19-25616	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1044	19-25475	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1049	19-24747	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1066	19-25688	Dep.(mn); $4.00(cy), 2(mn) CFSTI
1087	19-25455	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1089	19-24693	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1092	19-24613	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1111	19-25728	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1112	19-25729	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1115	19-25706	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1123	19-25707	Dep.(mn); $2.00(cy), 1(mn) CFSTI
PATENTS	**(British)**	**(3s. 6d. each, U. K. Patent Office)**
966,807	19-24928	
966,874	19-25740	
966,877	19-24829	
966,884	19-24830	
966,885	19-24831	
966,898	19-24533	
966,971	19-24687	
966,977	19-24832	
966,978	19-25646	
966,995	19-24688	
967,000	19-24910	
967,007	19-24631	
967,067	19-25647	
967,150	19-25648	
967,162	19-25711	
967,203	19-25649	
967,223	19-24546	
967,293	19-24659	
967,338	19-25650	
967,376	19-25712	
967,404	19-25651	
967,427	19-25713	
967,430	19-25614	
967,473	19-25714	
967,493	19-25259	
967,513	19-25652	
967,519	19-25653	
967,823	19-24632	
967,901	19-25654	
967,963	19-25116	
968,002	19-25655	
968,037	19-24633	
968,039	19-25715	
968,048	19-24871	
968,078	19-24697	
968,091	19-25656	
968,092	19-25657	
968,137	19-25658	
968,188	19-24872	
968,189	19-24873	
968,202	19-24534	
976,664	19-25117	
976,770	19-25466	
976,802	19-25697	
976,814	19-25260	
976,851	19-24660	
976,950	19-24966	
976,981	19-25659	
977,019	19-25660	
977,020	19-25661	
977,149	19-24967	
977,293	19-25662	
977,319	19-25663	
977,460	19-24634	
977,512	19-24929	
977,520	19-24635	
977,537	19-25664	
977,544	19-25716	
977,566	19-24636	
977,827	19-24833	
977,954	19-25261	
978,016	19-25665	
978,159	19-25666	
978,176	19-25698	
978,209	19-24874	
978,220	19-25667	
978,263	19-24968	
978,375	19-25668	
978,377	19-25717	
978,411	19-24601	
978,443	19-25669	
978,446	19-24969	
978,449	19-24930	
978,499	19-25637	
978,521	19-25467	

Report No.	Abstract No.	Availability
978,615	19-24970	
978,644	19-25670	
978,737	19-25718	
978,749	19-24834	
978,788	19-24661	
PATENTS	**(Canadian)**	
706,990	19-25671	
PATENTS	**(U. S.)**	**($0.25 each, U. S. Patent Office)**
3,153,280	19-24971	
3,153,566	19-25781	
3,153,568	19-24637	
3,153,571	19-24638	
3,153,617	19-25699	
3,153,618	19-25672	
3,158,924	19-24662	
3,158,929	19-24972	
3,159,452	19-24639	
3,159,545	19-24394	
3,159,548	19-25700	
3,159,549	19-25701	
3,159,744	19-24875	
3,159,745	19-24835	
3,159,747	19-24876	
3,159,748	19-24663	
3,160,490	19-24535	
3,160,745	19-24836	
3,160,750	19-24877	
3,160,768	19-25262	
3,161,950	19-24973	
3,162,581	19-25741	
3,163,580	19-25638	
3,163,581	19-25673	
3,163,582	19-25674	
3,163,583	19-25675	
3,163,584	19-25676	
3,163,585	19-25677	
3,163,589	19-24536	
3,163,610	19-24537	
3,163,752	19-24837	
3,163,756	19-24878	
3,163,761	19-24740	
3,163,765	19-24691	
3,164,487	19-24974	
3,164,525	19-25742	
3,164,526	19-25678	
3,164,527	19-25743	
3,164,528	19-25719	
3,164,529	19-25679	
3,164,530	19-25680	
3,164,720	19-24741	
3,164,739	19-25088	
3,165,349	19-25681	
3,165,446	19-25744	
3,165,447	19-25770	
3,165,449	19-25682	
3,173,983	19-24664	
3,177,373	19-24838	
3,177,482	19-24839	
3,177,554	19-25818	
3,179,581	19-24879	
3,179,723	19-24975	
3,180,704	19-24538	
3,180,800	19-25683	
3,181,004	19-25819	
PG-Report–	**(British)**	
469(Rev.)	19-24404	Dep.(mn); $0.50(BIS), 2s. 6d. (HMSO)
625	19-24405	Dep.; $0.30(BIS), 1s. 9d. (HMSO)
627	19-24846	Dep.; $0.80(BIS), 4s. (HMSO)
632	19-24406	Dep.; $0.30(BIS), 1s. 9d. (HMSO)
647	19-24748	Dep.
PNE–		
302F	19-24649	Dep.; $1.50(cy), 3(mn) CFSTI
420	19-25785	Dep.(mn); $5.00(cy), 3(mn) CFSTI
421	19-25786	Dep.(mn); $3.00(cy), 2(mn) CFSTI
422	19-25787	Dep.(mn); $1.00(cy), 1(mn) CFSTI
423	19-25788	Dep.(mn); $2.00(cy), 1(mn) CFSTI
424	19-25789	Dep.(mn); $2.00(cy), 1(mn) CFSTI
425	19-25790	Dep.(mn); $4.00(cy), 3(mn) CFSTI
426	19-25791	Dep.(mn); $2.00(cy), 1(mn) CFSTI
427	19-25792	Dep.(mn); $2.00(cy), 1(mn) CFSTI
428	19-25793	Dep.(mn); $1.00(cy), 1(mn) CFSTI
429	19-25794	Dep.(mn); $2.00(cy), 2(mn) CFSTI
439	19-25795	Dep.(mn); $1.00(cy), 1(mn) CFSTI
445	19-25796	Dep.(mn); $2.00(cy), 1(mn) CFSTI
446	19-25797	Dep.(mn); $2.00(cy), 1(mn) CFSTI
447	19-25798	Dep.(mn); $2.00(cy), 1(mn) CFSTI
448	19-25799	Dep.(mn); $1.00(cy), 1(mn) CFSTI
450	19-25800	Dep.(mn); $3.00(cy), 2(mn) CFSTI
455	19-25801	Dep.(mn); $1.00(cy), 1(mn) CFSTI
458	19-25802	Dep.(mn); $3.00(cy), 2(mn) CFSTI
459	19-25803	Dep.(mn); $5.00(cy), 3(mn) CFSTI
460	19-25804	Dep.(mn); $1.00(cy), 1(mn) CFSTI
461	19-25805	Dep.(mn); $2.00(cy), 1(mn) CFSTI
462	19-25806	Dep.(mn); $1.00(cy), 1(mn) CFSTI
463	19-25807	Dep.(mn); $3.00(cy), 2(mn) CFSTI
464	19-25808	Dep.(mn); $2.00(cy), 1(mn) CFSTI
475	19-25809	Dep.(mn); $3.00(cy), 3(mn) CFSTI
476	19-25810	Dep.(mn); $2.00(cy), 1(mn) CFSTI
478	19-25811	Dep.(mn); $3.00(cy), 2(mn) CFSTI
479	19-25812	Dep.(mn); $2.00(cy), 1(mn) CFSTI
PUC–		
1964-155	19-25523	Phys. Rev., 138: B773-7(1965)
RAD-SR–	**(Non-AEC)**	
63-159	19-24881	See GA-4395
RADC-TDR–	**(Misc.)**	
64-244	19-25555	$4.00(CFSTI)
RFP–		
506	19-24987	Dep.; $2.00(CFSTI)
522	19-24407	Dep.(mn); $1.00(cy), 1(mn) CFSTI
RFR–	**(Swedish)**	
197	19-24674	Dep.(mn)
RPI–	**(Misc.)**	
328-7	19-25456	Dep.(mn); $2.00(cy), 1(mn) CFSTI
328-28	19-25457	Dep.(mn); $2.00(cy), 1(mn) CFSTI
328-33	19-25458	Dep.(mn); $2.00(cy), 1(mn) CFSTI
RTD-TR–	**(Non-AEC)**	
65	19-25436	
SB–	**(Non-AEC)**	
403(Suppl.1)	19-24899	$0.10(CFSTI)
SC-R–		
64-1338	19-25813	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SC-RR–		
64-1651	19-24749	Dep.(mn); $1.00(cy), 1(mn) CFSTI
64-2141	19-24675	Dep.(mn); $2.00(cy), 1(mn) CFSTI
65-6	19-24650	Dep.; $4.00(cy), 3(mn) CFSTI
65-43	19-24903	Dep.; $6.00(cy), 6(mn) CFSTI
65-137	19-25814	Dep.; $1.00(cy), 1(mn) CFSTI
SC-TM–		
64-1735	19-25815	Dep.(mn); $1.00(cy), 1(mn) CFSTI
64-1791	19-24655	Dep.(mn); $2.00(cy), 1(mn) CFSTI
64-2154	19-24822	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-49	19-25816	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-63	19-24823	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-106	19-24824	Dep.(mn); $1.00(cy), 1(mn) CFSTI
261-63(14)	19-24884	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SLAC–		
34	19-25099	Dep.; $2.50(cy), 3(mn) CFSTI
SLAC-PUB–		
63	19-25529	Phys. Rev., 138: B847-50(1965)
SM–	**(Misc.)**	
62/65	19-25457	See RPI-328-28

Report No.	Abstract No.	Availability
STI-DOC–	**(International Atomic Energy Agency)**	
10/37	19-25767	$4.50; S94.50; £1.70; F.Fr.18,-; DM 15.75(IAEA)
SU–		
247-7	19-24676	Dep.(mn); $3.00(cy), 3(mn) CFSTI
SU-ML–		
1291	19-25556	Dep.(mn); $2.00(cy), 1(mn) CFSTI
SWRI–		
1228-51	19-24988	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1228-52	19-24988	See SWRI-1228-51
1228-53	19-24988	See SWRI-1228-51
TID–		
3910(Suppl.3)	19-24237	Dep.; $2.50(cy), 2(mn) CFSTI
21212	19-25751	Dep.(mn); $3.00(cy), 2(mn) CFSTI
21405	19-24885	Dep.; $2.00(cy), 1(mn) CFSTI
21525	19-25476	Dep.(mn); $3.00(cy), 2(mn) CFSTI
21542	19-25146	Dep.(mn); $2.00(cy), 2(mn) CFSTI
21635	19-24331	Radiation Botany, 5: 107-8(1965)
21649	19-24261	Dep.(mn); $3.00(cy), 2(mn) CFSTI
21653	19-25730	Dep.(mn); $3.00(cy), 2(mn) CFSTI
21667	19-25071	Dep.(mn); $7.00(cy), 6(mn) CFSTI
21673	19-24989	Dep.(mn); $4.00(cy), 3(mn) CFSTI
21682	19-25623	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21780	19-24262	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21790	19-24954	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21840	19-24488	Dep.(mn); $4.00(cy), 2(mn) CFSTI
TR–	**(Misc.)**	
62-14	19-24731	See VESIAC-7378VU
TRG-Report–	**(British)**	
270	19-24643	Dep.; $0.30(BIS), 1s. 9d. (HMSO)
511	19-25055	Dep.; $0.70(BIS), 3s. 6d. (HMSO)
522	19-24644	Dep.; $0.80(BIS), 4s. (HMSO)
848	19-25708	Dep.; $1.00(BIS), 5s. (HMSO)
862	19-25056	Dep.; $0.90(BIS), 4s. 6d. (HMSO)
863	19-25709	Dep.; $0.90(BIS), 4s. 6d. (HMSO)
894	19-25731	Dep.; $0.60(BIS), 3s. (HMSO)
902	19-24614	Dep.; $0.40(BIS), 2s. (HMSO)
917	19-25732	Dep.; $0.30(BIS), 1s. 9d. (HMSO)
TT–	**(Canadian)**	
65-30658	19-24227	See JPRS-29452
65-30663	19-24243	See JPRS-29457
65-30745	19-24264	See JPRS-29606
UCLA–		
12-523	19-24381	Dep.(mn); $2.00(cy), 1(mn) CFSTI
12-553	19-25817	Dep.(mn); $3.00(cy), 2(mn) CFSTI
UCRL–		
11141	19-24244	Biochim. Biophys. Acta, 90: 542-52(1964)
11596	19-24514	J. Inorg. Nucl. Chem., 27: 1079-84(1965)
11637	19-25073	Ann. Phys. (N. Y.), 32: 218-58(1965)
11776	19-25265	Dep.; $3.00(cy), 2(mn) CFSTI
11794	19-25521	Phys. Rev., 138: B766-9(1965)
11801	19-25100	Dep.(mn); $1.00(cy), 1(mn) CFSTI
11812	19-25101	Dep.(mn); $1.00(cy), 1(mn) CFSTI
11838	19-25349	Phys. Rev., 138: B892-5(1965)
11892	19-25357	Phys. Rev., 138: B969-79(1965)
11935	19-25102	Dep.; $1.00(cy), 1(mn) CFSTI
11952	19-25103	Dep.; $2.00(CFSTI)
11953(Rev.)	19-25173	Phys. Letters, 16: 35-6(1965)
11961	19-25266	Dep.(mn); $4.00(cy), 3(mn) CFSTI
11977	19-25624	Dep.(mn); $2.00(cy), 1(mn) CFSTI
11978	19-24382	Dep.(mn); $4.00(cy), 2(mn) CFSTI
12060	19-24651	J. Am. Water Works Assoc., 57: 429-36 (1965)
12068-T	19-25283	Nucl. Phys., 68: 691-4(1965)
12198	19-25352	Phys. Rev., 138: B921-32(1965)
12271	19-24645	Dep.; $3.00(cy), 2(mn) CFSTI
12314	19-24489	Dep.; $2.00(cy), 1(mn) CFSTI
12339(Vol.I)	19-24750	Dep.; $3.00(cy), 1(mn) CFSTI
12339(Vol.II)	19-24751	Dep.; $6.00(cy), 9(mn) CFSTI
12357(Rev.I)	19-24990	Dep.; $2.00(cy), 1(mn) CFSTI
12388	19-24752	Dep.; $1.00(cy), 1(mn) CFSTI
12405	19-24991	Dep.(mn); $2.00(cy), 1(mn) CFSTI
13137	19-25689	$7.00(CFSTI)
13143	19-24955	See USBM-RC-1157
16005	19-25519	Phys. Letters, 16: 71-2(1965)
UCRL-Trans–		
1203(L)	19-25626	Dep.(mn); $2.00(cy), 1(mn) CFSTI; $2.60(fs), $0.98(mf) JCL
1205(L)	19-24383	Dep.(mn); $1.60(fs), $0.80(mf) JCL
UNC–	**(Misc.)**	
5063	19-25710	Dep.(mn); $3.00(cy), 2(mn) CFSTI
5081	19-24923	Dep.(mn); $3.00(cy), 2(mn) CFSTI
5094	19-24992	Dep.(mn); $3.00(cy), 2(mn) CFSTI
UR–		
875-63	19-25244	See CONF-641004-6
USBM-RC–		
1157	19-24955	Dep.(mn); $2.00(cy), 1(mn) CFSTI
UWFL–		
88	19-24378	Dep.; $2.00(cy), 1(mn) CFSTI
VESIAC–	**(Non-AEC)**	
5218VU	19-24729	
5545VU	19-24730	
7378VU	19-24731	
7542VU	19-24732	
8580VU	19-24733	
8754VU	19-24734	
WADD-TR–	**(Non-AEC)**	
61-72(Vol.VII) (Suppl.)	19-24956	$2.00(CFSTI)
WANL-PR–	**(Misc.)**	
(P)-006	19-24957	$3.00(CFSTI)
WAPD-LPR–		
141	19-25733	Dep.(mn); $2.00(cy), 1(mn) CFSTI
154	19-25734	Dep.(mn); $5.00(cy), 4(mn) CFSTI
WCAP–	**(Misc.)**	
2056(Pt.IV)	19-24677	Dep.(mn); $4.00(cy), 3(mn) CFSTI
WL-TR–	**(Non-AEC)**	
64-160	19-24841	See FZK-208
Y–		
889	19-24993	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1480	19-24646	Dep.; $4.00(cy), 3(mn) CFSTI

Appendix I

NUCLEAR SCIENCE ABSTRACTS CATEGORY DEFINITIONS

BIOLOGY AND MEDICINE

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Ecology

Studies of the movement of radioactive and other materials through organisms and the environment and influence of these materials on natural communities. The measurement and hazards of radioactive materials in the biosphere are included in the subcategory *Radiation Hazards and Protection* of this category.

Metabolism, Tissue Distribution, and Toxicology

Chemical and metabolic processes in living organisms and the absorption, metabolism, utilization, and toxicological significance of materials ingested, inhaled, or otherwise entering the organisms. Studies performed to establish maximum allowable concentrations of radioactive materials are included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Effects

Information on the effects of radiation on organisms or their components, including radiation sickness.

Radiation Effects Therapy and Countermeasures

Use of biological extracts, chemical compounds, or drugs to alter, prevent, simulate, or treat the effects of radiation on organisms or their components. The use of special shields to prevent radiation effects is included in the subcategory *Radiation Hazards and Protection* of this category.

Radiation Hazards and Protection

Measurement and hazards of radioactive material in the biosphere; studies of maximum permissible concentrations of radioactive materials on organisms or their components; and the use of rules, procedures, and equipment to reduce radiation exposure. Users of this subcategory should also see the subject category HEALTH AND SAFETY.

Radiotherapy and Radiodiagnosis

Use of both external and internal radiation sources in the diagnosis and therapy of disease. Also includes all phases of radiation equipment, procedure, and effectiveness. For radiation side effects, see the subcategory *Radiation Effects* of this category.

CHEMISTRY

This category excludes *biochemistry*, which is found in the category BIOLOGY AND MEDICINE; *corrosion* which is a subcategory of METALS, CERAMICS, AND OTHER MATERIALS; and *geochemistry* which is included in the category GEOLOGY AND MINERALOGY.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Analytical Procedures

Qualitative and quantitative procedures, radiochemical analysis, neutron-activation analysis, and mass spectroscopy.

Inorganic and Physical Chemistry

Chemistry of elements and inorganic compounds and chemical thermodynamics. Chemistry of elements and inorganic compounds is also included in the subcategories *Analytical Procedures*, *Radiation Chemistry*, *Radiochemistry*, and *Separation Processes and Procedures* of this category and in the category METALS, CERAMICS, AND OTHER MATERIALS. Radiation effects on chemical properties and reactions are included in the subcategory *Radiation Chemistry* of this category.

Organic Chemistry

Chemical and physical properties and reactions of organic compounds and systems of compounds. Equipment and procedures for investigating such properties and reactions are also included. For radiation effects on organic compounds, see the subcategory *Radiation Chemistry* of this category. Also see the subcategory *Separation Processes and Procedures* of this category.

Radiation Chemistry

Radiation effects on chemical properties and reactions, radiation effects on physical properties of nonmetallic elements and compounds and organic compounds. Also includes the generation of visible light as a result of radiation. Radiation effects on biological materials are included in the subcategory *Radiation Effects* of the category BIOLOGY AND MEDICINE. Radiation effects on metals and intermetallic compounds are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Radiochemistry

Chemistry of radioactive materials and special chemical procedures and equipment required as a result of the presence of radiation. See also the subcategory *Separation processes and procedures* of this category and the category WASTE DISPOSAL AND PROCESSING.

Separation Processes and Procedures

Chemistry and chemical engineering for processing uranium and thorium ores and reactor fuel and breeder materials. Also includes chemical separations not designed for analytical purposes or for isotopic separations of an element. Analytical separations are included in the subcategory *Analytical Procedures* of this category, and separations of isotopes of an element are included in the category ISOTOPE TECHNOLOGY.

ENGINEERING

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of three or more subcategories.

Applications of Nuclear Explosions

Engineering applications of nuclear explosions or simulated nuclear explosions.

Facilities and Equipment

Plants, plant facilities, and equipment not designed for specific application in one of the other categories.

Heat Transfer and Fluid Flow

Theoretical studies and engineering applications of heat transfer and fluid flow. For thermodynamics and magnetofluiddynamics, see the subcategory *General* of the category PHYSICS.

Materials Testing

Information primarily concerned with equipment, methods, and techniques for destructive or nondestructive testing. When the material is of primary interest, information on testing (including corrosion and erosion) is included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Protective Structures

Design, construction, and effectiveness of blast and fallout shelters and other protective structures.

Space Propulsion

Design, development, testing, and evaluation of electric, ion, nuclear, plasma jet, and other propulsion methods for space use.

Vacuum Engineering

Design and construction of vacuum systems and equipment (e.g., vacuum pumps). Excludes properties of materials under vacuum environment and vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included in the subcategory *Accelerators* of the category PHYSICS).

GEOLOGY AND MINERALOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Natural Radioactivity and Fallout

Ground levels and movement of radioactive materials, both natural and artificial, and elemental and isotopic compositions of minerals.

Site Survey and Selection

Reactor and plant site-selection studies.

Techniques and Equipment

Use of radiometric techniques and equipment in geology and mineralogy, and seismology associated with nuclear-explosion detection.

Thorium and Uranium Minerals

Structures and properties of thorium and uranium minerals.

HEALTH AND SAFETY

Critical limits for moving and storing fissionable, radioactive, and toxic materials; experience in applied health physics; the development of, and experience with, personnel-protection procedures; and general industrial- and radiation-hazards analyses. Excludes studies performed to establish maximum allowable concentrations and limits of exposure, which are included in the subcategory *Radiation Hazards and Protection* of the category BIOLOGY AND MEDICINE.

INSTRUMENTATION

This category excludes the specific applications of an instrument. These are categorized by the subject of the application.

General

Design, testing, and use of instruments, except radiation detection, where these aspects of instrumentation are the main subjects.

Radiation Detection

Radiation-detection instruments and their components.

Radiation Effects

Effects of radiation on any instrument or instrument component.

ISOTOPE TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Industrial Applications

Applications to industrial processes and equipment for such applications. Applications to basic research are found under such categories as CHEMISTRY.

Power Application

Applications of radioisotopes in the production of electric or thermal energy or thrust.

Separation and Production

Separation of isotopes of one element in microquantities or macroquantities. Separation of isotopes of different elements is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

MATHEMATICS AND COMPUTERS

Pure mathematics; statistics; and the design, development, and operation of computers. Information on applied mathematics and computer applications is categorized according to the application (e.g., computers used as simulators of various devices and pro-

cesses are categorized in the same manner as the device or process simulated; computer codes and applied mathematics are categorized on the basis of the application).

METALS, CERAMICS, AND OTHER MATERIALS

The term "other materials" refers to such substances as plastics, rubbers, other elastomers, wood, concrete, graphite, and petroleum.

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Corrosion

Corrosion and erosion studies that appear to be directed toward specific applications. Excludes studies primarily concerned with physical chemistry, reaction kinetics, etc., which are included in the category CHEMISTRY.

Fabrication

Fabrication methods, procedures, and equipment, including those for fuel elements and reactor components.

Properties and Structure

Mechanical, physical, and structural properties.

Radiation Effects

Effects of radiation on mechanical, physical, and structural properties. Chemical effects of radiation are included in the subcategory *Radiation Chemistry* of the category CHEMISTRY.

METEOROLOGY

Atmospheric and weather conditions, climatology, general meteorological problems, and meteorological studies made for the purpose of obtaining information on the movement of air-borne particulate matter. Meteorology included in site-selection reports is included in the subcategory *Site Survey and Selection* of the category GEOLOGY AND MINERALOGY.

PHYSICS

General

Information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Accelerators

Theory, design, development, construction, and operation of high-voltage machines and particle accelerators.

Astrophysics and Cosmology

Origin and cosmic abundance of elements, isotopic composition of meteorites, stellar processes, and stellar magnetic fields.

Atomic Physics

Physical properties and theory of atoms and their interactions, reactions, and scattering. Also includes the production of atomic beams and the effects and mechanisms of atomic beam bombardment of materials.

Cosmic Radiation

Origin, intensity variations, acceleration processes, etc., of cosmic radiation. For the properties of specific cosmic particles or the use of cosmic radiation merely as a source of high-energy particles, see the subcategories *Elementary Particles and Radiations* and *Nuclear Properties and Reactions* of this category, depending on the emphasis.

Criticality Studies

Basic studies of nuclear criticality. Critical limits of movement and storage of radioactive materials are included in the category HEALTH AND SAFETY. Criticality studies pertaining to reactors are included in the category REACTOR TECHNOLOGY.

Direct Energy Conversion

Equipment, techniques, and theory of direct-energy conversion, including magnetohydrodynamic cells and thermionic cells.

Elementary Particles and Radiations

Properties and theory, including interactions with each other. The diffusion of particles and radiations in shielding materials and configurations is included in the subcategory *Shielding* of this category.

Field Theory and Quantum Mechanics

Basic studies of the behavior and interactions of fields, the kinetics of field-matter systems, and the quantization of energy and energy transfer. Specific applications of field theory and quantum mechanics are found in other subcategories.

Geophysics

Geomagnetic fields, upper atmosphere physics, and physics of the crust and interior of the earth; this excludes cosmic radiation.

Low Temperature Physics

Cryogenics, superconductivity, and superfluidity research. Applications are found under categories for the applications.

Neutron Physics

Experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Such studies conducted for a specified application are categorized according to the application (e.g., the category REACTOR TECHNOLOGY and the subcategories *Criticality Studies* and *Shielding* of this category). Neutron reactions with specific nuclei are included in the subcategory *Nuclear Properties and Reactions* of this category.

Nuclear Properties and Reactions

Experimental and theoretical studies relating to properties, reactions, and interactions of nuclei.

Plasma Physics and Thermonuclear Processes

Phenomena of electric discharges; fundamental plasma experiments and theory; theory, design, development, and experimentation relating to controlled release of energy from thermonuclear reactions; and research and theory on electrodynamics and magnetodynamics applicable to plasma studies and thermonuclear processes.

Shielding

Theoretical and experimental studies relating to the diffusion, attenuation, absorption, and scattering of particles and radiations in shielding materials and configurations. For information on the fabrication of shielding materials and configurations, see the subcategory *Fabrication* of the category METALS, CERAMICS, AND OTHER MATERIALS.

Solid State Physics

Includes studies on crystallography, the theory of the structure of metals, alloys, and ionic crystals, cohesive forces, band structure, thermal vibration, intrinsic photoconductivity, plasticity, lattice defects, color centers, and dislocation theory. Users of this subcategory should also see the subcategory *Inorganic and Physics Chemistry* in the subject category CHEMISTRY and the subcategory *Properties and Structure* of the category METALS, CERAMICS, AND OTHER MATERIALS.

REACTOR TECHNOLOGY

General

Information applicable to the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Auxiliaries and Components

Design and construction of auxiliaries, components, control systems, and instrumentation not intended for a specific reactor.

Criticality Studies

Theoretical and experimental studies of neutron physics and parameters of unspecified reactors.

Design and Feasibility

Design and feasibility studies of reactor types not designated as power, process heat, production, propulsion, research, or test and not associated with a specific reactor.

Fuels

Design and theory of fuel elements not associated with a specific reactor. Studies of fuel-element materials are included in the category METALS, CERAMICS, AND OTHER MATERIALS.

Power and Power-Breeder Reactors

Design, construction, feasibility, operation, and economics of specific reactors and classes of reactors. Also includes auxiliaries, components, and criticality studies for such reactors.

Process Heat Reactors

Reactors designed to produce heat for uses other than the production of electricity or propulsion. Reactors designed to produce electricity and process heat are included in the subcategory *Power and Power-breeder Reactors* of this category.

Production Reactors

Design, construction, feasibility, economics, and operation of reactors devoted primarily to the production of fissionable materials or isotopes. Also includes auxiliaries, components, and criticality studies for such reactors.

Propulsion and Space

Design, construction, feasibility, economics, and operation of reactors for the propulsion of vehicles (land, water, air, and space). Also includes auxiliaries, components, and criticality studies for such reactors. The vehicles themselves are included only if the influence on the reactor is considered.

Research and Test Reactors

Design, construction, feasibility, economics, and operation of reactors used for radiation-effects studies and other basic research. Also includes auxiliaries, components, and criticality studies for such reactors.

WASTE DISPOSAL AND PROCESSING

Chemistry and chemical engineering for the storage, disposal, and control of radioactive waste materials, including the treatment of waste materials prior to disposal, such as concentration, neutralization, filtration, or calcination. Safety aspects of radioactive waste handling and disposal are included in the category HEALTH AND SAFETY. Ecological aspects of waste materials are included in the subcategory *Ecology* of the category BIOLOGY AND MEDICINE. Some radiochemical aspects are included in the subcategory *Radiochemistry* of the category CHEMISTRY. Fuel-element processing is included in the subcategory *Separation Processes and Procedures* of the category CHEMISTRY.

GENERAL AND MISCELLANEOUS

This category, for the most part, contains abstracts of research and development reports of the U. S. Atomic Energy Commission and its contractors that are essentially nonnuclear in nature or are outside the scope of the other categories in *NSA*. Such abstracts have been included in *Research and Development Abstracts of the USAEC*. *RDA* was discontinued after issue number 8, Dec. 1963.

Additionally, both AEC and non-AEC originated broad summary type documents with diverse subject matter will be found under this category.

Appendix II

JOURNAL LIST

This is a list of journals and their abbreviations arranged alphabetically by the abbreviation used in *NSA*. Titles marked by an asterisk (*) are those that are scanned regularly. Titles without asterisks are journals from which some abstracts were taken during Volume 19, Numbers 1 through 12, although these journals are not scanned regularly.

The Russian journals identified by a dagger (†) are available commercially in complete English translation.

Cross references have been included for some non-English language titles as well as for variant forms of titles used in this list. For journals on the present scanning list that fall in either of these categories, the asterisk appears only with the form of the title used for *NSA*. Some journals which have undergone name changes in recent years have been so identified parenthetically after the title. The original language title for a translated journal is given in parentheses after the English title.

Abhandl. Deut. Akad. Wiss. Berlin, Kl. Med.
Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Medizin *(Germany)*

Abstr. Japan. Sci. Tech. Periodicals
*Abstracts of Articles Published in Japanese Scientific and Technical Periodicals *(U. S.)*

Acad. Rep. Populare Romine, Baza Cercetari Stiint. Timisoara, Studii Cercetari, Stiinte Chim.
Academia Republicii Populare Romine, Baza de Cercetari Stiintifice Timisoara, Studii si Cercetari, Stiinte Chimice *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Biochim.
Academia Republicii Populare Romine, Institutul de Biochemie, Studii si Cercetari de Biochimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Chim.
Academia Republicii Populare Romine, Studii si Cercetari de Chimie *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Fiz.
*Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Inframicrobiol.
Academia Republicii Populare Romine, Institutul de Inframicrobiologie, Studii si Cercetari de Inframicrobiologie *(Romania)*

Acta Anat.
*Acta Anatomica *(Switzerland)*

Acta Biochim. Biophys. Sinica
Acta Biochimica et Biophysica Sinica
see Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao

Acta Biochim. Polon.
Acta Biochimica Polonica *(Poland)*

Acta Biochim. Polon. (English Transl.)
*Acta Biochimica Polonica (English Translation) *(Poland)*

Acta Biol. Exptl. Sinica
Acta Biologiae Experimentalis Sinica
see Shih Yen Sheng Wu Hsueh Pao

Acta Biol. Med. Ger.
Acta Biologica et Medica Germanica *(Germany)*

Acta Boton. Sinica
Acta Botanica Sinica
see Chih Wu Hsueh Pao

Acta Chem. Scand.
*Acta Chemica Scandinavica *(Denmark)*

Acta Chim. Acad. Sci. Hung.
*Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Chim. Sinica
Acta Chemica Sinica
see Hua Hsueh Hsueh Pao

Acta Chir. Acad. Sci. Hung.
Acta Chirurgica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Cient. Venezolana
*Acta Cientifica Venezolana *(Venezuela)*

Acta Cryst.
*Acta Crystallographica *(Denmark)*

Acta Cytol.
*Acta Cytologica *(U. S.)*

Acta Endocrinol.
Acta Endocrinologica *(Denmark)*

Acta Entomol. Sinica
Acta Entomologica Sinica
see K'un Ch'ung Hsueh Pao

Acta Fac. Rerum Nat. Univ. Comenianae, Botan.
Acta Facultatis Rerum Naturalium Universitatis Comenianae, Botanica *(Czechoslovakia)*

Acta Geophys. Polon.
*Acta Geophysica Polonica *(Poland)*

Acta Geophys. Sinica
Acta Geophysica Sinica
see Ti Ch'iu Wu Li Hsueh Pao

Acta Gerontol.
*Acta Gerontologica *(Italy)*

Acta Ginecol.
Acta Ginecologica *(Spain)*

Acta Gynaecol. Obstet. Hispano Lusitana
*Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*

Acta Haematol. Japon.
Acta Haematologica Japonica
see Nippon Ketsueki Gakkai Zasshi

Acta Hepato-Splenol.
Acta Hepato-Splenologica *(Germany)*

Acta Histochem.
*Acta Histochemica *(Germany)*

Acta Iberica Radiol.-Cancerol.
Acta Iberica Radiologica-Cancerologica *(Spain)*

Acta IMEKO (Intern. Messstech. Konf.), 1961
*Acta IMEKO (Internationale Messtechnische Konferenz), 1961 *(Hungary)*

Acta Isotopica
*Acta Isotopica *(Italy)*

Acta Med. Hidalguense
*Acta Medica Hidalguense *(Mexico)*

Acta Med. Iranica
*Acta Medica Iranica *(Iran)*

Acta Med. Okayama
*Acta Medicinae Okayama *(Japan)*

Acta Med. Polona
*Acta Medica Polona *(Poland)*

Acta Met.
*Acta Metallurgica *(U. S.)*

Acta. Met. Sinica
Acta Metallurgica Sinica
see Chin Shu Hsueh Pao

Acta Microbiol. Acad. Sci. Hung.
Acta Microbiologica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Microbiol. Polon.
*Acta Microbiologica Polonica *(Poland)*

Acta Morphol. Acad. Sci. Hung.
Acta Morphologica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Morphol. Neerl.-Scand.
*Acta Morphological Neerlando-Scandinavica *(Netherlands)*

Acta Neurochir.
Acta Neurochirurgica *(Austria)*

Acta Neurol. Latinoam.
*Acta Neurologia Latinoamericana *(Uruguay)*

Acta Neuropsiquiat. Arg.
*Acta Neuropsiquiatrica Argentina *(Argentina)*

Acta Odontol. Scand.
Acta Odontologica Scandinavica *(Sweden)*

Acta Paediat.
*Acta Paediatrica *(Sweden)*

Acta Pathol. Japon.
*Acta Pathologica Japonica *(Japan)*

Acta Pathol. Microbiol. Scand.
Acta Pathologica et Microbiologica Scandinavica *(Denmark)*

Acta Phys. Acad. Sci. Hung.
*Acta Physica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Phys. Austriaca
*Acta Physica Austriaca *(Austria)*

Acta Phys. Austriaca, Suppl.
*Acta Physica Austriaca, Supplementum *(Austria)*

Acta Physiol. Acad. Sci. Hung.
Acta Physiologica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Physiol. Polon.
*Acta Physiologica Polonica *(Poland)*

Acta Physiol. Scand.
Acta Physiologica Scandinavica *(Sweden)*

Acta Phys. Polon.
*Acta Physica Polonica *(Poland)*

Acta Phys. Sinica
Acta Physica Sinica
see **Wu Li Hsueh Pao**

Acta Polytech. Scand., Phys. Nucl. Ser.
Acta Polytechnica Scandinavica, Physics including Nucleonics Series *(Sweden)*

Acta Radiol., Suppl.
*Acta Radiologica, Supplementum *(Sweden)*

Acta Radiol. Therapy, Phys., Biol.
*Acta Radiologica. Therapy, Physics, Biology *(Sweden)*

Acta Rheumatol. Scand.
*Acta Rheumatologica Scandinavica *(Sweden)*

Acta Schol. Med. Gifu
Acta Scholae Medicinalis in Gifu
see **Gifu Ika Daigaku Kiyo**

Acta Schol. Med., Univ. Kioto
Acta Scholae Medicinalis, Universitatis in Kiota *(Japan)*

Actas Dermo-Sifilog.
*Actas Dermo-Sifilograficas *(Spain)*

Acta Soc. Med. Upsalien.
*Acta Societatis Medicorum Upsaliensis *(Sweden)*

Acta Soc. Ophthalmol. Japon.
Acta Societatis Ophthalmologicae Japonicae
see **Nippon Ganka Gakkai Zasshi**

Acta Tech. CSAV
Acta Technica CSAV (Ceskoslovenska Akademia Ved) (formerly Acta Technica (Prague)) *(Czechoslovakia)*

Acta Unio Intern. Contra Cancrum
*Acta Unio Internationalis Contra Cancrum *(Belgium)*

Acta Univ. Debrecen. Ludovico Kossuth Nom., Ser. Phys. Chim.
Acta Universitatis Debreceniensis de Ludovico Kossuth Nominatae, Series Physica et Chimica *(Hungary)*

Acta Univ. Palackianae Olomuc.
Acta Universitatis Palackianae Olomucensis *(Czechoslovakia)*

Acta Virol. (Prague)
*Acta Virologica (Prague) *(Czechoslovakia)*

Acta Zool. Sinica
Acta Zoological Sinica
see **Tung Wu Hsueh Pao**

Actualites Pharmacol.
Actualites Pharmacologiques *(France)*

Adhesion Adhesives (Kyoto)
Adhesion and Adhesives (Kyoto)
see **Setchaku**

Advan. Electron. Electron Phys.
Advances in Electronics and Electron Physics *(U. S.)*

Advan. Energy Conversion
*Advanced Energy Conversion *(England)*

Advan. Obstet. Gynaecol.
Advances in Obstetrics and Gynaecology
see **Sanfujinka no Shimpo**

Advan. Phys.
*Advances in Physics *(England)*

Advan. Radiation Biol.
Advances in Radiation Biology *(U. S.)*

A E G Mitt.
*A E G Mitteilungen *(Germany)*

AEI (Assoc. Elec. Ind.) Eng.
*AEI (Associated Electrical Industries) Engineering *(England)*

Aerospace Med.
Aerospace Medicine (formerly The Journal of Aviation Medicine) *(U. S.)*

Aerztl. Forsch.
Aerztliche Forschung *(Germany)*

Afrique Franc. Chir.
*Afrique Francaise Chirurgicale *(Algeria)*

Aggiorn. Mal. Infezione
*Aggiornamenti sulle Malattie da Infezione *(Italy)*

Agr. Biol. Chem. (Tokyo)
*Agricultural and Biological Chemistry (Tokyo) *(Japan)*

Agr. Eng.
Agricultural Engineering *(U. S.)*

Agr. Ital. (Pisa)
Agricoltura Italiana, L' (Pisa) *(Italy)*

Agron. Lusitana
*Agronomia Lusitana *(Portugal)*

AIAA (Am. Inst. Aeron. Astronaut.) J.
*AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*

A.I.Ch.E. (Am. Inst. Chem. Engrs.) J.
*A.I.Ch.E. (American Institute of Chemical Engineers) Journal *(U. S.)*

Air Conditioning, Heating, Ventilating
Air Conditioning, Heating and Ventilating *(U. S.)*

Akad. Nauk Ukr. RSR, Inst. Teploenerg., Zb. Prats
*Akademiya Nauk Ukrain'skoi RSR, Institut Teploenergetiki, Zbirnik Prats *(Ukrainian S.S.R.)*

Alberta Med. Bull.
Alberta Medical Bulletin *(Canada)*

Alexandria Med. J.
*Alexandria Medical Journal, The *(Egypt)*

Algerie Med.
*Algerie Medicale *(Algeria)*

Allison Res. Eng.
*Allison Research and Engineering *(U. S.)*

Am. Ceram. Soc. Bull.
*American Ceramic Society Bulletin, The *(U. S.)*

Am. Heart J.
American Heart Journal *(U. S.)*

Am. Ind. Hyg. Assoc. J.
*American Industrial Hygiene Association Journal *(U. S.)*

Am. J. Anat.
American Journal of Anatomy, The *(U. S.)*

Am. J. Botany
*American Journal of Botany *(U. S.)*

Am. J. Clin. Pathol.
*American Journal of Clinical Pathology *(U. S.)*

Am. J. Digest. Diseases
American Journal of Digestive Diseases, The *(U. S.)*

Am. J. Diseases Children
American Journal of Diseases of Children *(U. S.)*

Am. J. Epidemiol.
American Journal of Epidemiology (formerly American Journal of Hygiene) *(U. S.)*

Am. J. Gastroenterol.
American Journal of Gastroenterology, The *(U. S.)*

Am. J. Human Genet.
*American Journal of Human Genetics, The *(U. S.)*

Am. J. Obstet. Gynecol.
American Journal of Obstetrics and Gynecology *(U. S.)*

Am. J. Ophthalmol.
American Journal of Ophthalmology *(U. S.)*
Am. J. Pathol.
*American Journal of Pathology, The *(U. S.)*
Am. J. Phys.
*American Journal of Physics *(U. S.)*
Am. J. Phys. Anthropol.
American Journal of Physical Anthropology *(U. S.)*
Am. J. Physiol.
*American Journal of Physiology, The *(U. S.)*
Am. J. Roentgenol., Radium Therapy Nucl. Med.
*American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, The *(U. S.)*
Am. J. Surg.
American Journal of Surgery, The *(U. S.)*
Am. J. Vet. Res.
American Journal of Veterinary Research *(U. S.)*
Am. Machinist/Metalworking Manuf.
American Machinist/Metalworking Manufacturing *(U. S.)*
Am. Mineralogist
*American Mineralogist, The *(U. S.)*
Am. Naturalist
*American Naturalist *(U. S.)*
Am. Rev. Respirat. Diseases
American Review of Respiratory Diseases *(U. S.)*
Am. Scientist
American Scientist (formerly The Sigma Xi Quarterly) *(U. S.)*
Am. Soc. Metals, Trans. Quart.
*American Society for Metals, Transactions Quarterly *(U. S.)*
Am. Soc. Testing Mater., Spec. Tech. Publ.
American Society for Testing and Materials, Special Technical Publication *(U. S.)*
Anais Acad. Brasil. Cienc.
*Anais da Academia Brasileira de Ciencias *(Brazil)*
Anais Brasil. Dermatol. Sifilog.
*Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*
Anais Brasil. Ginecol. (Rio de Janeiro)
*Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*
Anais Inst. Med. Trop. (Lisbon)
*Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*
Anal. Abstr.
*Analytical Abstracts *(England)*
Anal. Biochem.
*Analytical Biochemistry *(U. S.)*
Anal. Chem.
*Analytical Chemistry *(U. S.)*
Anal. Chim. Acta
*Analytica Chimica Acta *(Netherlands)*
Analele Stiint. Univ. "A. I. Cuza," Iasi, Sect. I
Analele Stiintifice ale Universitatii "A. I. Cuza," din Iasi, Sectiunea I *(Romania)*
Analele Univ. "C. I. Parhon," Ser. Stiint. Nat.
Analele Universitatii "C. I. Parhon," Seria Stiintele Naturii (formerly Analele Universitatii "C. I. Parhon" Bucuresti, Seria Stiintelor Naturii) *(Romania)*
Anales Hosp. Militar Central (Lima, Peru)
*Anales del Hospital Militar Central (Lima, Peru) *(Peru)*
Anales Inst. Corachan (Barcelona)
*Anales del Instituto Corachan (Barcelona) *(Spain)*
Anales Inst. Oncol. "Angel H. Roffo"
*Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*
Anales Med. Cir.
*Anales de Medicina y Cirugia *(Spain)*
Anales Real Acad. Nacl. Med. (Madrid)
*Anales de la Real Academia Nacional de Medicina (Madrid) *(Spain)*
Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie A *(Spain)*
Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B
*Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*
Anales Soc. Cient. Arg.
*Anales de la Sociedad Cientifica Argentina *(Argentina)*
Analyst
*Analyst, The *(England)*
Anesthesiology
Anesthesiology *(U. S.)*
Angew. Chem.
Angewandte Chemie *(Germany)*
Angew. Chem. Intern. Ed. Engl.
Angewandte Chemie. International Edition in English *(U. S.–Germany)*
Angiologia (Barcelona)
*Angiologia (Barcelona) *(Spain)*
Ann. Acad. Med. Lodz.
Annales Academiae Medicae Lodzensis *(Poland)*
Ann. Acad. Sci. Fennicae, Ser. A VI
*Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*
Ann. Agr. Fenniae
Annales Agriculturae Fenniae *(Finland)*
Ann. Allergy
*Annals of Allergy *(U. S.)*
Ann. Anat. Pathol.
*Annales d'Anatomie Pathologique *(France)*
Ann. Biochem. Exptl. Med. (Calcutta)
*Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*
Ann. Chem.
Annalen der Chemie, Justus Liebigs *(Germany)*
Ann. Chim. (Rome)
Annali di Chimica (Rome) *(Italy)*
Ann. Chir. Gynaecol. Fenniae
*Annales Chirurgiae et Gynaecologie Fenniae *(Finland)*
Ann. Chir. Semaine Hop.
Annales de Chirurgie, La Semaine des Hopitaux *(France)*
Annee Biol.
Annee Biologique, L' *(France)*
Ann. Endocrinol. (Paris)
Annales d'Endocrinologie (Paris) *(France)*
Ann. Entomol. Soc. Am.
Annals of the Entomological Society of America *(U. S.)*
Ann. Gembloux
Annales de Gembloux *(Belgium)*
Ann. Geophys.
Annales de Geophysique *(France)*
Ann. Histochim.
Annales d'Histochimie *(France)*
Ann. Inst. Henri Poincare
*Annales de l'Institut Henri Poincare *(France)*
Ann. Inst. Pasteur
Annales de l'Institut Pasteur *(France)*
Ann. Internal Med.
Annals of Internal Medicine *(U. S.)*
Ann. Intern. Geophys. Yr.
*Annals of the International Geophysical Year *(England)*
Ann. Ital. Chir.
Annali Italiani di Chirurgia *(Italy)*
Ann. Med. Exptl. Biol. Fenniae (Helsinki)
Annales Medicinae Experimentalis et Biologiae Fenniae (Helsinki) *(Finland)*
Ann. Med. Navale (Rome)
Annali di Medicina Navale (Rome) (formerly Annali di Medicina Navale e Tropicale) *(Italy)*
Ann. Nutr. Aliment.
Annales de la Nutrition et de l'Alimentation *(France)*
Ann. N. Y. Acad. Sci.
*Annals of the New York Academy of Sciences *(U. S.)*
Ann. Occupational Hyg.
*Annals of Occupational Hygiene *(England)*
Ann. Ostet. Ginecol.
*Annali di Ostetricia e Ginecologia *(Italy)*
Annotationes Zool. Japon.
Annotationes Zoologicae Japonenses *(Japan)*
Ann. Otol. Rhinol. Laryngol.
Annals of Otology, Rhinology, and Laryngology *(U. S.)*
Ann. Paediat. Fenniae
*Annales Paediatriae Fenniae *(Finland)*
Ann. Paediat. Japon.
*Annales Paediatrici Japonici, Kioto Universitatis *(Japan)*
Ann. Pharm. Franc.
Annales Pharmaceutiques Francaises *(France)*
Ann. Phys. (N. Y.)
*Annals of Physics (New York) *(U. S.)*
Ann. Phys. (Paris)
*Annales de Physique (Paris) *(France)*
Ann. Physik
*Annalen der Physik *(Germany)*
Ann. Radioelec.
*Annales de Radioelectricite *(France)*

Ann. Radiol.
*Annales de Radiologie *(France)*

Ann. Rept. Eng. Res. Inst.
Annual Report of the Engineering Research Institute
see *Soga Shikensho Nempo*

Ann. Rept. Japan. Assoc. Radiation Res. Polymers
Annual Report of the Japanese Association for Radiation Research on Polymers
see *Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo*

Ann. Rept. Radiation Center Osaka Prefect.
*Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*

Ann. Rev. Astronomy Astrophys.
Annual Review of Astronomy and Astrophysics *(U. S.)*

Ann. Rev. Nucl. Sci.
*Annual Review of Nuclear Science *(U. S.)*

Ann. Rev. Phys. Chem.
*Annual Review of Physical Chemistry *(U. S.)*

Ann. Rheumatic Diseases
*Annals of the Rheumatic Diseases *(England)*

Ann. Roy. Coll. Surg. Engl.
Annals of the Royal College of Surgeons of England *(England)*

Ann. Sclavo
*Annali Sclavo *(Italy)*

Ann. Soc. Sci. Bruxelles. Ser. I
*Annales de la Societe Scientifique de Bruxelles. Serie I *(Belgium)*

Ann. Surg.
Annals of Surgery *(U. S.)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio AA *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio D *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. E
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio E *(Poland)*

Ann. Univ. Saraviensis, Med.
Annales Universitatis Saraviensis, Medizin-Medecine *(Germany)*

Anotaciones Pediat. (Medellin, Colombia)
*Anotaciones Pediatricas (Medellin, Colombia) *(Colombia)*

Antibiotiki
Antibiotiki† *(U.S.S.R.)*

APCA (Air Pollution Control Assoc.) Abstr.
*APCA (Air Pollution Control Association) Abstracts *(U. S.)*

Appl. Mater. Res.
Applied Materials Research (formerly Materials Research) *(England)*

Appl. Microbiol.
*Applied Microbiology *(U. S.)*

Appl. Opt.
*Applied Optics *(U. S.)*

Appl. Phys. Letters
*Applied Physics Letters *(U. S.)*

Appl. Sci. Res., Sect. A
*Applied Scientific Research, Section A *(Netherlands)*

Appl. Sci. Res., Sect. B
*Applied Scientific Research, Section B *(Netherlands)*

Appl. Spectry.
*Applied Spectroscopy *(U. S.)*

Appl. Therap.
Applied Therapeutics *(Canada)*

Arbok Univ. Bergen, Mat.-Nat. Ser.
*Arbok for Universitetet i Bergen, Matematikk-Naturvitenskap Serie *(Norway)*

Arch. Anat. Microscop. Morphol. Exptl.
*Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*

Arch. Arg. Pediat.
Archivos Argentinos de Pediatria *(Argentina)*

Arch. Automat. Telemech.
*Archiwum Automatyki i Telemechaniki *(Poland)*

Arch. Biochem. Biophys.
*Archives of Biochemistry and Biophysics *(U. S.)*

Arch. Biol. (Liege)
*Archives de Biologie (Liege) *(Belgium)*

Arch. Bioquim., Quim. Farm. Tucuman
*Archivos de Bioquimica, Quimica y Farmacia, Tucuman *(Argentina)*

Arch. Bodowy Maszyn
*Archiwum Bodowy Maszyn *(Poland)*

Arch. Dermatol.
Archives of Dermatology (formerly A.M.A. Archives of Dermatology) *(U. S.)*

Arch. "De Vecchi" Anat. Patol. Med. Clin.
Archivio "De Vecchi" per l'Anatomia Patologica e la Medicina Clinica *(Italy)*

Arch. Elektrotech.
*Archiwum Elektrotechniki *(Poland)*

Arch. Elek. Uebertrag.
Archiv der Elektrischen Uebertragung *(Germany)*

Arch. Entwicklungsmech. Organ.
Archiv fuer Entwicklungsmechanik der Organismen, Wilhelm Roux' *(Germany)*

Arch. Environ. Health
*Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*

Arch. Exptl. Pathol. Pharmakol.
Archiv fuer Experimentelle Pathologie und Pharmakologie, Naunyn-Schmiedebergs *(Germany)*

Arch. Ges. Physiol.
Archiv fuer die Gesamte Physiologie des Menschen und der Tiere, Pfluegers *(Germany)*

Arch. Gornictwa
*Archiwum Gornictwa *(Poland)*

Arch. Hosp. Univ. (Havana)
*Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*

Arch. Hosp. Vargas (Caracas)
*Archivos del Hospital Vargas (Caracas) *(Venezuela)*

Arch. Hutnictwa
*Archiwum Hutnictwa *(Poland)*

Arch. Hyg. Bakteriol.
*Archiv fuer Hygiene und Bakteriologie *(Germany)*

Arch. Immunol. Terapii Doswiadczalnej
Archiwum Immunologii i Terapii Doswaidczalnej
see *Arch. Immunol. Therap. Exptl.*

Arch. Immunol. Therap. Exptl.
*Archivum Immunologiae et Therapiae Experimentalis *(Poland)*

Arch. Interam. Rheumatol.
*Archives of Interamerican Rheumatology *(Brazil)*

Arch. Internal Med.
Archives of Internal Medicine (formerly A.M.A. Archives of Internal Medicine) *(U. S.)*

Arch. Intern. Pharmacodyn.
*Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*

Arch. Intern. Physiol. Biochim.
Archives Internationales de Physiologie et de Biochimie *(Belgium)*

Arch. Ital. Biol.
*Archives Italiennes de Biologie *(Italy)*

Arch. Ital. Otol. Rinol. Laringol.
Archivio Italiano di Otologia, Rinologia e Laringologia *(Italy)*

Arch. Kinderheilk.
Archiv fuer Kinderheilkunde *(Germany)*

Arch. Maladies Profess. Med. Trav. Securite Sociale
Archives des Maladies Professionnelles de Medecine du Travail et de Securite Sociale *(France)*

Arch. Med. Mex.
*Archivos Medicos Mexicanos *(Mexico)*

Arch. Meterol., Geophys. Bioklimatol., Ser. A
Archiv fuer Meterologie, Geophysik und Bioklimatologie, Series A *(Austria)*

Arch. Ophthalmol.
Archiv fuer Ophthalmologie Vereinigt mit Archiv fuer Augenheilkunde, Albrecht von Graefes *(Germany)*

Arch. Ortoped.
Archivio di Ortopedia *(Italy)*

Arch. Otolaryngol.
Archives of Otolaryngology *(U. S.)*

Arch. Pathol.
Archives of Pathology (formerly A.M.A. Archives of Pathology) *(U. S.)*

Arch. Peru. Patol. Clin. (Lima)
*Archivos Peruanos de Pathologia y Clinica (Lima) *(Peru)*

Arch. Pharm.
Archiv der Pharmazie und Berichte der Deutschen Pharmazeutischen Gesellschaft (includes Mitteilungen der Deutschen Pharmazeutischen Gesellschaft und der Pharmazeutischen Gesellschaft der DDR) *(Germany)*

Arch. Physik. Therapie
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(Germany)*

Arch. Phys. Med. Rehabil.
Archives of Physical Medicine and Rehabilitation *(U. S.)*

Arch. Psychiat. Nervenkrankh.
Archiv fuer Psychiatrie und Nervenkrankheiten Vereinigt mit Zeitschrift fuer die Gesamte Neurologie und Psychiatrie *(Germany)*

Arch. Roumaines Pathol. Exptl. Microbiol.
*Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*

Arch. Soc. Estud. Clin. Habana
*Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*

Arch. Surg.
Archives of Surgery *(U. S.)*

Arch. Tech. Messen
Archiv fuer Technisches Messen und Industrielle Messtechnik *(Germany)*

Arch. Union Med. Balkan.
Archives de l'Union Medicale Balkanique *(Romania)*

Arch. Venezolanos Patol. Trop. Parasitol. Med.
*Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*

Argonne Natl. Lab. Rev.
*Argonne National Laboratory Reviews (supersedes News-Bulletin International (Argonne National Laboratory)) *(U. S.)*

Arhiv Farm. (Belgrade)
Arhiv za Farmaciju (Belgrade) *(Yugoslavia)*

Arkiv Fysik
*Arkiv for Fysik *(Sweden)*

Arkiv Fys. Seminar Trondheim
*Arkiv for det Fysiske Seminar i Trodheim *(Norway)*

Arkiv Kemi
*Arkiv for Kemi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

Arquiv. Brasil. Cardiol.
*Arquivos Brasileiros de Cardiologia *(Brazil)*

Arquiv. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)
*Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*

Arquiv. Mineiros Leprol.
*Arquivos Mineiros de Leprologia *(Brazil)*

Arquiv. Patol. (Lisbon)
*Arquivos de Patologia (Lisbon) *(Portugal)*

Arquiv. Tisiol.
*Arquivos de Tisiologia *(Portugal)*

Arthritis Rheumat.
*Arthritis and Rheumatism *(U. S.)*

Arzneimittel-Forsch.
Arzneimittel-Forschung *(Germany)*

Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Association Belge pour le Development Pacifique de l'Energie Atomique, Bulletin d'Information *(Belgium)*

Assoc. Food Drug Officials U. S., Quart. Bull.
Association of Food & Drug Officials of the United States, Quarterly Bulletin *(U. S.)*

Astronaut. Acta
*Astronautica Acta *(Austria)*

Astronaut. Aeronaut.
*Astronautics & Aeronautics (formerly Astronautics and Aerospace Engineering) *(U. S.)*

Astronautyka
*Astronautyka *(Poland)*

Astron. Zh.
Astronomicheskii Zhurnal† *(U.S.S.R.)*

Astrophys. J.
*Astrophysical Journal, The *(U. S.)*

Astrophys. J., Suppl. Ser.
*Astrophysical Journal, The, Supplement Series *(U. S.)*

Astrophys. Norvegica
*Astrophysica Norvegica *(Norway)*

Ateneo Parmense
*Ateneo Parmense, L' *(Italy)*

At. Energ. (USSR)
*Atomnaya Energiya† *(U.S.S.R.)*

At. Energy Australia
*Atomic Energy in Australia *(Australia)*

At. Energy Rev.
*Atomic Energy Review *(Austria)*

At. Kozlemen.
*Atomki Kozlemenyek (formerly carried under the title: Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek) *(Hungary)*

Atomdokumentation
*Atomdokumentation. Selektiv Litteraturlesta *(Sweden)*

Atomics
*Atomics *(U. S.)*

Atomkernenergie
*Atomkernenergie (formerly Atomenergie) *(Germany)*

Atomlight
*Atomlight *(U. S.)*

Atompraxis
*Atompraxis *(Germany)*

Atomtech. Tajekoztato
*Atomtechnikai Tajekoztato *(Hungary)*

Atomwirtschaft
*Atomwirtschaft, Die *(Germany)*

Atoomenergie Haar Toepassingen
*Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*

At. Strom
*Atom und Strom *(Germany)*

Atti Accad. Med. Lombarda
Atti della Accademia Medica Lombarda *(Italy)*

Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat.
*Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Accad. Sci. Torino: I. Classe Sci. Fis., Mat. Nat.
*Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*

Atti Assoc. Genet. Ital.
*Atti Associazone Genetica Italiana *(Italy)*

Atti, Ist. Veneto Sci., Lettere Arti, Classe Sci. Mat. Nat.
Atti, Istituto Veneto di Scienze, Lettere ed Arti, Classe di Scienze Matematiche e Naturali *(Italy)*

Atti Seminar. Mat. Fis. Univ. Modena
*Atti del Seminario Matematico e Fisico dell'Universita di Modena *(Italy)*

Atti Soc. Ital. Cardiol.
Atti della Societa Italiana di Cardiologia *(Italy)*

Atti Soc. Ital. Sci. Vet.
Atti della Societa Italiana de Scienze Veterinarie *(Italy)*

Atti Soc. Nat. Mat. Modena
*Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*

Atti Soc. Peloritana Sci. Fis. Mat. Nat.
Atti della Societa Peloritana di Scienze Fisiche Matematiche e Naturali *(Italy)*

Attualita Ostet. Ginecol.
Attualita di Ostetrica e Ginecologia *(Italy)*

Australasian Ann. Med.
Australasian Annals of Medicine *(Australia)*

Australian J. Appl. Sci.
*Australian Journal of Applied Science *(Australia)*

Australian J. Biol. Sci.
Australian Journal of Biological Sciences *(Australia)*

Australian J. Chem.
*Australian Journal of Chemistry *(Australia)*

Australian J. Exptl. Biol. Med. Sci.
Australian Journal of Experimental Biology and Medical Science, The *(Australia)*

Australian J. Phys.
*Australian Journal of Physics *(Australia)*

Automatisme
Automatisme *(France)*

Automazione Automatismi
*Automazione e Automatismi *(Italy)*

Automazione Strumentazione
Automazione e Strumentazione *(Italy)*

Avian Diseases
Avian Diseases *(U. S.)*

Azerb. Khim. Zh.
*Azerbaidzhanskii Khimicheskii Zhurnal *(Azerbaidzhan S.S.R.)*

Battelle Tech. Rev.
*Battelle Technical Review *(U. S.)*

BCIRA (Brit. Cast Iron Res. Assoc.) J.
BCIRA (British Cast Iron Research Association) Journal *(England)*

Beitr. Pathol. Anat. Allgem. Pathol.
*Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*

Beitr. Plasmaphysik
*Beitraege aus der Plasmaphysik *(Germany)*

Belgicatom, Assoc. Belge Develop. Pacifique Energie At., Bull. Inform.
Belgicatom, Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information (formerly Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Belg. Tijdschr. Geneesk.
Belgisch Tijdschrift voor Geneeskunde *(Belgium)*

Bell System Tech. J.
Bell System Technical Journal, The *(U. S.)*

Ber. Bunsenges. Physik. Chem.
*Berichte der Bunsengesellschaft fuer Physikalische Chemie (formerly Zeitschrift fuer Elektrochemie) *(Germany)*

Ber. Deut. Keram. Ges.
*Berichte der Deutschen Keramischen Gesellschaft e. V. *(Germany)*

Berufsdermatosen
Berufsdermatosen *(Germany)*

Bibliotheca Haematol.
Bibliotheca Haematologica, Supplementa ad Acta Haematologica *(Switzerland)*

Biken's J.
Biken's Journal *(Japan)*

Bilten Inst. Nukl. Nauke "Boris Kidric"
Bilten Instituta za Nuklearne Nauke "Boris Kidric"† *(Yugoslavia)*

Biochem. Biophys. Res. Commun.
*Biochemical and Biophysical Research Communications *(U. S.)*

Biochemistry
*Biochemistry *(U. S.)*

Biochemistry (Tokyo)
Biochemistry (Tokyo)
see Seikagaku

Biochemistry (USSR) (English Transl.)
*Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*

Biochem. J.
*Biochemical Journal *(England)*

Biochem. Pharmacol.
*Biochemical Pharmacology *(England)*

Biochem. Z.
Biochemische Zeitschrift *(Germany)*

Biochim. Biophys. Acta
*Biochimica et Biophysica Acta *(U. S.)*

Biofizika
Biofizika† *(U.S.S.R.)*

Biokhimiya
Biokhimiya† *(U.S.S.R.)*

Biol. Bull.
Biological Bulletin, The *(U. S.)*

Biol. Kozlemen.
Biologiai Kozlemenyek *(Hungary)*

Biol. Neonatorum
*Biologia Neonatorum *(Switzerland)*

Biologia
Biologia *(Czechslovakia)*

Biologica (Santiago)
Biologica (Santiago) *(Chile)*

Biol. Rev. Cambridge Phil. Soc.
Biological Reviews of the Cambridge Philosophical Society *(England)*

Biophysics (USSR) (English Transl.)
*Biophysics (USSR) (English Translation of Biofizika) *(England)*

Biophysik
*Biophysik *(Germany)*

Biophys. J.
*Biophysical Journal *(U. S.)*

Biophys. J., Suppl.
*Biophysical Journal, Supplement *(U. S.)*

Biophys. Soc. Abstr.
*Biophysical Society Abstracts *(U. S.)*

Bitamin
Bitamin (Vitamins (Kyoto)) *(Japan)*

Blood
*Blood. The Journal of Hematology *(U. S.)*

Blut
Blut *(Germany)*

Boei Eisei
*Boei Eisei (National Defense Medical Journal) *(Japan)*

Bol. Asoc. Med. Puerto Rico
*Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*

Bol. Fac. Ing. Agri-Mensura Montevideo
*Boletin de la Facultad de Ingenieria y Agri-Mensura de Montevideo *(Uruguay)*

Bol. Hosp. Oftalmol. Nuestra Senora de la Luz
*Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*

Bol. Inst. Estud. Med. Biol. (Mex.)
*Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*

Bol. Inst. Mat. Astron. Fis.
*Boletin del Instituto de Matematica Astronomia y Fisica *(Argentina)*

Bol. Junta Control Energia At. (Peru)
*Boletin de la Junta do Control de Energia Atomica (formerly Boletin de Informaciones de la Junta do Control de Energia Atomica) *(Peru)*

Boll. Ist. Sieroterap. Milan.
*Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*

Boll. Mal. Orecchio, Gola, Naso
Bollettino delle Malattie dell'Orecchio, della Gola, del Naso *(Italy)*

Boll. Oculist.
Bollettino d'Oculistica *(Italy)*

Boll. Soc. Ital. Biol. Sper.
Bollettino della Societa Italiana di Biologia Sperimentale *(Italy)*

Bol. Real Soc. Espan. Hist. Nat. Secc. Biol.
Boletin de la Real Sociedad Espanola de Historia Natural, Seccion Biologica *(Spain)*

Bol. Soc. Cubana Dermatol. Sifilog.
*Boletin de la Sociedad Cubana de Dermatologia y Sifilografia *(Cuba)*

Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"
*Boletin de la Sociedad Medica del Centro Maternao "Gral. Maximino Avila Camacho" *(Mexico)*

Bol. Trab. Soc. Cir. Buenos Aires
*Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*

Bol. Univ. Parana, Fis. Teorica
*Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*

Bombay Technologist
*Bombay Technologist *(India)*

Botan. Bull. Acad. Sinica (Taiwan)
*Botanical Bulletin of Academia Sinica (Taiwan) *(China)*

Botan. Mag. (Tokyo)
Botanical Magazine, The (Tokyo) *(Japan)*

Bratislav. Lekarske Listy
Bratislavske Lekarske Listy *(Czechoslovakia)*

Brennstoff-Waerme-Kraft
*Brennstoff-Waerme-Kraft *(Germany)*

Brigham Young Univ. Sci. Bull., Biol. Ser.
*Brigham Young University Science Bulletin, Biological Series *(U. S.)*

Brit. Chem. Eng.
*British Chemical Engineering *(England)*

Brit. Columbia Med. J.
*British Columbia Medical Journal *(Canada)*

Brit. Heart J.
British Heart Journal *(England)*

Brit. J. Appl. Phys.
*British Journal of Applied Physics *(England)*

Brit. J. Cancer
*British Journal of Cancer *(England)*

Brit. J. Haematol.
British Journal of Haematology *(England)*

Brit. J. Non-Destructive Testing
British Journal of Non-Destructive Testing *(England)*

Brit. J. Nutr.
British Journal of Nutrition, The *(England)*

Brit. J. Radiol.
*British Journal of Radiology *(England)*

Brit. Med. J.
British Medical Journal, The *(England)*

Bryologist
Bryologist, The *(U. S.)*

Bul. Inst. Politeh. Bucuresti
Buletinul Institutului Politehnic Bucuresti *(Romania)*

Bull. Acad. Polon. Sci., Ser. Sci. Biol.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Biologiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Chim.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Chimiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Geol. Geograph.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Geologiques et Geographiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences, Mathematiques, Astronomiques et Physiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci., Tech.
*Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Techniques *(Poland)*

Bull. Aeron. Res. Inst., Univ. Tokyo
Bulletin of the Aeronautical Research Institute, University of Tokyo
see Tokyo Daigaku Koku Kenkyusho Shuho

Bull. Assoc. Franc. Etude Cancer
Bulletin de l'Association Francaise pour l'Etude du Cancer *(France)*

Bull. Astron. Inst. Czech.
*Bulletin of the Astronomical Institutes of Czechoslovakia *(Czechoslovakia)*

Bull. Atmospheric Radioactivity (Japan)
Bulletin of the Atmospheric Radioactivity (Japan)
see Taiki Hoshano Kansoku Seiseki

Bull. Boris Kidrich Inst. Nucl. Sci.
*Bulletin of the Boris Kidrich Institute of Nuclear Sciences *(Yugoslavia)*

Bull. Cancer Inst. Okayama Univ. Med. School
Bulletin of the Cancer Institute, Okayama University Medical School, The *(Japan)*

Bull. Chem. Soc. Japan
*Bulletin of the Chemical Society of Japan *(Japan)*

Bull. Classe Sci., Acad. Roy. Belg.
*Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*

Bull. Electrotech. Lab. (Tokyo)
Bulletin of the Electrotechnical Laboratory (Tokyo)
see Denki Shikensho Iho

Bull. Exptl. Biol. Med. (USSR) (English Transl.)
Bulletin of Experimental Biology and Medicine (USSR) (English Translation of Byulleten Eksperimental'noi Biologii i Meditsiny) *(U. S.)*

Bull. Fac. Med. Istanbul
Bulletin de la Faculte de Medecine d'Istanbul *(Turkey)*

Bull. Federation Soc. Gynecol. Obstet. Langue Franc.
Bulletin de la Federation des Societes de Gynecologie et d'Obstetrique de Langue Francaise *(France)*

Bull. Georgia Acad. Sci.
Bulletin of the Georgia Academy of Science *(U. S.)*

Bull. Heart Inst., Japan
*Bulletin of the Heart Institute, Japan *(Japan)*

Bull. Hosp. Joint Diseases
*Bulletin of the Hospital for Joint Diseases *(U. S.)*

Bull. Inform. Appl. Ind. Radioelements
*Bulletin d'Information sur les Applications Industrielles des Radioelements. Supplement au Bulletin d'Information de l'A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*

Bull. Inform. Assoc. Belge Develop. Pacifique Energie At.
*Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*

Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.)
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire) *(France)*

Bull. Inform. Sci. Tech. (Paris)
*Bulletin d'Information Scientifique et Technique (Paris) *(France)*

Bull. Inst. Agron. Sta. Rech. Gembloux
Bulletin de l'Institut Agronomique et des Stations de Recherches de Gembloux *(Belgium)*

Bull. Inst. Chem., Acad. Sinica
*Bulletin of the Institute of Chemistry, Academia Sinica *(China)*

Bull. Inst. Chem. Res., Kyoto Univ.
*Bulletin of the Institute for Chemical Research, Kyoto University *(Japan)*

Bull. Inst. Nucl. Sci. "Boris Kidrich" (Belgrade)
*Bulletin of the Institute of Nuclear Science "Boris Kidrich" (Belgrade) *(Yugoslavia)*

Bull. Inst. Public Health (Tokyo)
Bulletin of the Institute of Public Health (Tokyo)
see Koshu Eiseiin Kenkyu Hokoku

Bull. Japan. Soc. Sci. Fisheries
Bulletin of the Japanese Society of Scientific Fisheries
see Nippon Siusan Gakkaishi

Bull. JSME (Japan Soc. Mech. Engrs.)
Bulletin of JSME (Japan Society of Mechanical Engineers) *(Japan)*

Bull. Math. Biophys.
Bulletin of Mathematical Biophysics *(U. S.)*

Bull. Mineral Res. Exploration Inst. Turkey, Foreign Ed.
*Bulletin of the Mineral Research and Exploration Institute of Turkey, Foreign Edition *(Turkey)*

Bull. Natl. Inst. Agr. Sci., Ser. G
Bulletin of the National Institute of Agricultural Sciences, Series G
see Nogyo Gijutsu Kenkyusho Hokoku, Chikusan

Bull. N. Y. Acad. Med.
*Bulletin of the New York Academy of Medicine *(U. S.)*

Bull. Parenteral Drug Assoc.
Bulletin of the Parenteral Drug Association *(U. S.)*

Bull. Pharm. (Peking)
Bulletin of Pharmacology (Peking)
see Yao Hsueh T'ung Pao

Bull. Rheumatic Diseases
*Bulletin on Rheumatic Diseases *(U. S.)*

Bull. Schweiz. Akad. Med. Wiss.
Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*

Bull. Schweiz. Elektrotech. Ver.
Bulletin des Schweizerischen Elektrotechnischen Vereins *(Switzerland)*

Bull. Sci., Conseil Acad. RPF Yougoslavie
*Bulletin Scientifique, Conseil des Academies de la RPF Yougoslavie *(Yugoslavia)*

Bull. Sci. Eng. Res. Lab., Waseda Univ.
Bulletin of Scientific and Engineering Research Laboratory, Waseda University
see Waseda Daigaku Rikogaku Kenkyusho Hokoku

Bull. Seismol. Soc. Am.
Bulletin of the Seismological Society of America *(U. S.)*

Bull. Soc. Belge Geol., Paleontol. Hydrol.
Bulletin de la Societe Belge de Geologie, de Paleontologie et d'Hydrologie *(Belgium)*

Bull. Soc. Chim. Belges
*Bulletin des Societes Chimiques Belges *(Belgium)*

Bull. Soc. Chim. Biol.
Bulletin de la Societe de Chimie Biologique *(France)*

Bull. Soc. Chim. France
*Bulletin de la Societe Chimique de France *(France)*

Bull. Soc. Franc. Mineral. Crist.
*Bulletin de la Societe Francaise de Mineralogie et de Cristallographie *(France)*

Bull. Soc. Intern. Chir.
Bulletin de la Societe Internationale de Chirurgie *(Belgium)*

Bull. Soc. Roy. Belge Gynecol. Obstet.
*Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*

Bull. Soc. Roy. Sci. Liege
*Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*

Bull. Soc. Sci. Bretagne
*Bulletin de la Societe Scientifique de Bretagne *(France)*

Bull. Soc. Vaudoise Sci. Nat.
*Bulletin de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*

Bull. Textile Res. Inst. Japan. Govt.
Bulletin of the Textile Research Institute of Japanese Government
see Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku

Bull. Tokyo Inst. Technol.
Bulletin of the Tokyo Institute of Technology *(Japan)*

Bull. Tokyo Inst. Tech., Ser. B
Bulletin of the Tokyo Institute of Technology, Series B *(Japan)*

Bull. Univ. Osaka Prefect., Ser. B
Bulletin of the University of Osaka Prefecture, Series B *(Japan)*

Bull. Va. Polytech. Inst., Eng. Expt. Sta. Ser.
Bulletin of the Virginia Polytechnic Institute, Engineering Experiment Station Series *(U. S.)*

Bull. World Health Organ.
Bulletin of the World Health Organization *(U. S.)*

Bunseki Kagaku
*Bunseki Kagaku (Japan Analyst) *(Japan)*

Burma Med. J.
*Burma Medical Journal *(Burma)*

Byul. Eksperim. Biol. i Med.
*Byulleten Eksperimental'noi Biologii i Meditsiny† *(U.S.S.R.)*

Byul. Tekhn.-Ekon. Inform., Sov. Nar. Khoz. Ivanovsk. Ekon. Admin. Raiona
Byulleten Tekhniko-Ekonomicheskoi Informatsii, Sovet Narodnogo Khozyaistva Ivanovskogo Ekonomicheskogo Administrativnogo Raiona *(U.S.S.R.)*

Cahiers Phys.
*Cahiers de Physique *(France)*

Calif. Med.
*California Medicine *(U. S.)*

CA, Med. J.
CA, A Medical Journal Published by the American Cancer Society *(U. S.)*

Can. Aeronaut. Space J.
*Canadian Aeronautics and Space Journal *(Canada)*

Cancer
*Cancer *(U. S.)*

Cancer Bull., Texas Ed.
Cancer Bulletin, Texas Edition *(U. S.)*

Cancer Chemotherapy Rept.
*Cancer Chemotherapy Reports *(U. S.)*

Cancer Res.
*Cancer Research *(U. S.)*

Can. Chem. Process.
*Canadian Chemical Processing *(Canada)*

Can. Controls Instr.
Canadian Controls and Instrumentation *(Canada)*

Can. Electron. Eng.
Canadian Electronics Engineering *(Canada)*

Can. Geophys. Bull.
*Canadian Geophysical Bulletin *(Canada)*

Can. J. Biochem.
*Canadian Journal of Biochemistry (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Chem.
*Canadian Journal of Chemistry *(Canada)*

Can. J. Chem. Eng.
*Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*

Can. J. Earth Sci.
*Canadian Journal of Earth Sciences *(Canada)*

Can. J. Genet. Cytol.
*Canadian Journal of Genetics and Cytology *(Canada)*

Can. J. Math.
*Canadian Journal of Mathematics *(Canada)*

Can. J. Med. Technol.
*Canadian Journal of Medical Technology, The *(Canada)*

Can. J. Microbiol.
*Canadian Journal of Microbiology *(Canada)*

Can. J. Phys.
*Canadian Journal of Physics *(Canada)*

Can. J. Physiol. Pharmacol.
*Canadian Journal of Physiology and Pharmacology (supersedes in part Canadian Journal of Biochemistry and Physiology) *(Canada)*

Can. J. Public Health
*Canadian Journal of Public Health *(Canada)*

Can. J. Zool.
*Canadian Journal of Zoology *(Canada)*

Can. Math. Bull.
*Canadian Mathematical Bulletin *(Canada)*

Can. Med. Assoc. J.
*Canadian Medical Association Journal, The *(Canada)*

Can. Met. Quart.
*Canadian Metallurgical Quarterly *(Canada)*

Can. Mining J.
*Canadian Mining Journal *(Canada)*

Can. Nucl. Technol.
*Canadian Nuclear Technology *(Canada)*

Can. Patent Office Record
*Canadian Patent Office Record *(Canada)*

Can. Power Engr.
*Canadian Power Engineer *(Canada)*

Can. Serv. Med. J.
*Canadian Services Medical Journal *(Canada)*

Can. Spectr.
*Canadian Spectroscopy *(Canada)*

Cardiologia
*Cardiologia *(Switzerland)*

Caryologia
*Caryologia *(Italy)*

Casopis Lekaru Ceskych
Casopis Lekaru Ceskych *(Czechoslovakia)*

Ceram. Age
Ceramic Age *(U. S.)*

Ceram. Ind.
Ceramic Industry *(U. S.)*

CERN Courier
*CERN Courier *(Switzerland)*

Cesk. Casopis Fys.
*Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*

Cesk. Fysiol.
Ceskoslovenska Fysiologie *(Czechoslovakia)*

Cesk. Gastroenterol. Vyziva
Ceskoslovenska Gastroenterologie a Vyziva, Sbornik pro Pathofysiologii Traveni a Vyzivy *(Czechoslovakia)*

Cesk. Hyg.
Ceskoslovenska Hygiena *(Czechoslovakia)*

Cesk. Morfol.
Ceskoslovenska Morfologie *(Czechoslovakia)*

Cesk. Radiol.
Ceskoslovenska Radiologie (formerly Ceskoslovenska Rentgenologie) *(Czechoslovakia)*

Cesk. Stomatol.
Ceskoslovenska Stomatologie *(Czechoslovakia)*

Chem. Anal. (Warsaw)
*Chemia Analityczna (Warsaw) *(Poland)*

Chem. Ber.
Chemische Berichte *(Germany)*

Chem. Bull. (Peking)
Chemical Bulletin (Peking)
see Hua Hsueh Tung Pao

Chem. Can.
*Chemistry in Canada *(Canada)*

Chem. Chem. Ind. (Japan)
Chemistry and Chemical Industry (Japan)
see Kagaku to Kogyo (Tokyo)

Chem. Commun.
*Chemical Communications *(England)*

Chem. Eng.
Chemical Engineering with Chemical & Metallurgical Engineering *(U. S.)*

Chem. Eng. (Japan)
Chemical Engineering (Japan)
see Kagaku Kogaku

Chem. Eng. Progr.
*Chemical Engineering Progress *(U. S.)*

Chem. Eng. Progr., Symp. Ser.
Chemical Engineering Progress, Symposium Series *(U. S.)*

Chem. Eng. Sci.
*Chemical Engineering Science *(U. S.)*

Chem. High Polymers (Tokyo)
Chemistry of High Polymers (Tokyo)
see Kobunshi Kagaku

Chemiker Ztg.
Chemiker Zeitung *(Germany)*

Chem. Ind. (London)
*Chemistry & Industry (London) *(England)*

Chem. Ind. (Tokyo)
Chemical Industry (Tokyo)
see Kagaku Kogyo

Chem.-Ingr.-Tech.
*Chemie-Ingenieur-Technik *(Germany)*

Chemist-Analyst
*Chemist-Analyst, The *(U. S.)*

Chemistry
Chemistry *(U. S.)*
Chemistry (Kyoto)
Chemistry (Kyoto)
see Kagaku (Kyoto)
Chemistry (Taipei)
Chemistry (Taipei) *(China)*
Chem. Listy
*Chemicke Listy *(Czechoslovakia)*
Chemotherapia
Chemotherapia *(Switzerland)*
Chem. Process Eng.
*Chemical & Process Engineering (including Atomic World) *(England)*
Chem. Prumysl
Chemicky Prumysl *(Czechoslovakia)*
Chem. Rev.
*Chemical Reviews *(U. S.)*
Chem. Stosowana, Ser. A.
*Chemia Stosowana, Seria A *(Poland)*
Chem. Stosowana, Ser. B
*Chemia Stosowana, Seria B *(Poland)*
Chem. Tech. (Leipzig)
*Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*
Chem. Weekblad
Chemische Weekblad *(Netherlands)*
Chem. World (Shanghai)
Chemical World (Shanghai)
see Hua Hsueh Shih Chieh
Chem. Zvesti
Chemicke Zvesti *(Czechoslovakia)*
Chih Wu Hsueh Pao
Chih Wu Hsueh Pao (Acta Botanica Sinica) *(China)*
Chijiki Kansokujo Yoho
Chijiki Kansokujo Yoho (Memoirs of the Kakioka Magnetic Observatory *(Japan)*
Chim. Anal.
*Chimie Analytique (Paris) *(France)*
Chimia (Aarau)
*Chimia (Aarau) *(Switzerland)*
Chim. Ind. (Milan)
Chimica, La, e l'Industria (Milan) *(Italy)*
Chinese J. Phys. (Taiwan)
*Chinese Journal of Physics (Taiwan) *(China)*
Chinese Med. J.
Chinese Medical Journal, The *(China)*
Chin Shu Hsueh Pao
Chin Shu Hsueh Pao (Acta Metallurgica Sinica) *(China)*
Chir. Praxis
Chirurgische Praxis. Zeitschrift fuer die Gesamte Chirurgie *(Austria)*
Chirurg
Chirurg, Der *(Germany)*
Chromatog. Rev.
Chromatographic Reviews *(U. S.)*
Chung Kuo K'o Hsueh
Chung Kuo K'o Hsueh
see Sci. Scinica (Peking)
Cir. Cirujanos
*Cirurgia y Cirujanos *(Mexico)*
Circulation
Circulation *(U. S.)*
Cir. Giencol. Urol.
*Cirugia, Ginecologia, y Urologia *(Spain)*
Clin. All-round (Osaka)
Clinics All-round (Osaka)
see Sogo Rinsho
Clin. Chem.
*Clinical Chemistry *(U. S.)*
Clin. Chim. Acta
*Clinica Chimica Acta *(Netherlands)*
Clin. Med.
Clinical Medicine *(U. S.)*
Clin. Neurosurg.
Clinical Neurosurgery *(U. S.)*
Clin. Radiol.
Clinical Radiology *(Scotland)*
Clin. Radiol. (Japan)
Clinical Radiology (Japan)
see Rinsho Hoshasen

Clin. Sci.
Clinical Science *(England)*
Collection Czech. Chem. Commun.
*Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*
Colloq. Met., 7e, Centre Etudes Nucl. Saclay, (Gif-sur-Yvette, France), 1963
Colloque de Metallurgie, Ecrouissage, Restauration, Recristallisation, 7e [Colloque], Centre d'Etudes Nucleaires de Saclay, (Gif-sur-Yvette, France), June 27-28, 1963 (Pub. 1963) *(France)*
Comit. Nazl. Energia Nucl., Notiziario
*Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*
Commun. ACM (Assoc. Computing Machinery)
*Communications of the ACM (Association for Computing Machinery) *(U. S.)*
Communist Chinese Sci. Abstr.
*Communist Chinese Scientific Abstracts *(U. S.)*
Compt. Rend.
*Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences *(France)*
Compt. Rend. Acad. Bulgare Sci.
Comptes Rendus de l'Academie Bulgare des Sciences *(Bulgaria)*
Compt. Rend. Rech. (Inst. Encour. Rech. Sci. Ind. Agr.)
*Comptes Redus de Recherches (Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture) *(Belgium)*
Compt. Rend. Soc. Biol.
*Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*
Compt. Rend. Soc. Franc. Gynecol.
*Comptes Rendus de la Societe Francaise de Gynecologie *(France)*
Comun. Acad. Rep. Populare Romine
Comunicarile Academiei Republicii Populare Romine *(Romania)*
Conn. Med.
Connecticut Medicine *(U. S.)*
Consulting Engr. (London)
Consulting Engineer, The *(England)*
Contemp. Phys.
*Contemporary Physics *(England)*
Contrib. Boyce Thompson Inst.
Contributions from Boyce Thompson Institute *(U. S.)*
Copeia
Copeia *(U.S.)*
Cornell Vet.
Cornell Veterinarian, The *(U.S.)*
Corrosion
*Corrosion *(U. S.)*
Corrosion Anti-Corrosion
*Corrosion et Anti-Corrosion *(France)*
Corrosion Sci.
*Corrosion Science *(U. S.)*
Corrosion Technol.
Corrosion Technology *(England)*
Croat. Chem. Acta
*Croatica Chemica Acta *(Yugoslavia)*
Crop Sci.
Crop Science *(U. S.)*
Cryogenics
*Cryogenics *(England)*
Current Sci. (India)
*Current Science *(India)*
Current Therap. Res.
Current Therapeutic Research, Clinical and Experimental *(U. S.)*
Cytogenetics
*Cytogenetics *(Switzerland)*
Czech. J. Phys.
*Czechoslovak Journal of Physics *(Czechoslovakia)*
Daedalus
Daedalus *(U. S.)*
Danish Med. Bull.
*Danish Medical Bulletin *(Denmark)*
Dansk Kemi
Dansk Kemi *(Denmark)*
Dechema Monograph.
Dechema Monographien *(Germany)*
Delaware Med. J.
Delaware Medical Journal *(U. S.)*

Denki Gakkai Zasshi
Denki Gakkai Zasshi (The Journal of the Institute of Electric Engineers of Japan) *(Japan)*

Denki Kagaku
Denki Kagaku (Journal of the Electrochemical Society of Japan) *(Japan)*

Denki Shikensho Iho
*Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*

Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku
Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku (Electrical Communication Laboratory, Technical Journal) *(Japan)*

Dermatologica
*Dermatologica *(Switzerland)*

Dermatol. Wochschr.
Dermatologische Wochenschrift *(Germany)*

Deut. Gesundheitsw.
Deutsche Gesundheitswesen, Das *(Germany)*

Deut. Lebensm.-Rundschau
Deutsche Lebensmittel-Rundschau *(Germany)*

Deut. Med. Wochschr.
Deutsche Medizinische Wochenschrift *(Germany)*

Deut. Z. Verdauungs- Stoffwechselkrankh.
*Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*

Develop. Biol.
*Developmental Biology *(U. S.)*

Diabetes
Diabetes *(U. S.)*

Discovery
*Discovery *(England)*

Discussions Faraday Soc.
*Discussions of the Faraday Society *(England)*

Diseases Chest
Diseases of the Chest *(U. S.)*

Dissertation Abstr.
*Dissertation Abstracts *(U. S.)*

Dobutsugaku Zasshi
Dobutsugaku Zasshi (The Zoological Magazine) *(Japan)*

Doitai To Hoshasen
Doitai To Hoshasen (Isotopes and Radiation) *(Japan)*

Dokl. Akad. Nauk Arm. SSR
*Doklady Akademii Nauk Armyanskoi SSR *(Armenian S.S.R.)*

Dokl. Akad. Nauk Belorussk. SSR
Doklady Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*

Dokl. Akad. Nauk SSSR
*Doklady Akademii Nauk SSSR† *(U.S.S.R.)*

Dokl. Bolgar. Akad. Nauk
Doklady Bolgarskoi Akademii Nauk
see ***Compt. Rend. Acad. Bulgare Sci.***

Dokl. i Soobshch. Uzhgorodsk. Gos. Univ., Ser. Fiz. Mat. Nauk
Doklady i Soobshcheniya Uzhgorodskogo Gosudarstvennogo Universiteta, Seriya Fiziko-Matematicheskikh Nauk *(Ukrainian S.S.R.)*

Dopovidi Akad. Nauk Ukr. RSR
*Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*

"Easa" (J. Engrs.' Assoc. (S. Africa))
"Easa" (The Journal of the Engineers' Association (South Africa)) *(S. Africa)*

East European Sci. Abstr.
*East European Scientific Abstracts *(U. S.)*

Ecol. Monographs
Ecological Monographs *(U. S.)*

Econ. Geol.
*Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*

Egeszsegtudomany
Egeszsegtudomany *(Hungary)*

Eiyogaku Zasshi
Eiyogaku Zasshi (The Japanese Journal of Nutrition) *(Japan)*

Eiyo To Shokuryo
Eiyo To Shokuryo—Eiyo Shokuryo Gakkaishi (Journal of the Japanese Society of Food and Nutrition) *(Japan)*

Ekol. Polska, Ser. B
*Ekologia Polska, Seria B *(Poland)*

Eksperim. Khirurg. i Anesteziol.
Eksperimental'naya Khirurgia i Anesteziologiya *(U.S.S.R.)*

Eksperim. Med. i Morfol.
Eksperimentalna Meditsina i Morfologiya *(Bulgaria)*

Elec. Commun. Lab. Tech. J.
Electrical Communication Laboratory, Technical Journal
see ***Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku***

Elec. Export Rev.
*Electrical Export Review *(England)*

Elec. Rev.
Electrical Review *(England)*

Electricite
*Electricite *(France)*

Electrochem. Technol.
*Electrochemical Technology *(U. S.)*

Electrochim. Acta
*Electrochimica Acta *(U. S.)*

Electron. Design
Electronic Design *(U. S.)*

Electron. Eng.
*Electronic Engineering Incorporating Electronics, Television and Short Wave World *(England)*

Electronics
* Electronics *(U. S.)*

Electronics (Japan)
Electronics (Japan)
see ***Erekutoronikusu***

Electron. Ind.
Electronic Industries *(U. S.)*

Electron. Letters
Electronics Letters *(England)*

Electron. Power
*Electronics and Power *(England)*

Electron. Record
*Electronics Record *(England)*

Elec. West
Electrical West *(U.S.)*

Elektron. Rundschau
Elektronische Rundschau *(Germany)*

Elektrotech. Obzor
Elektrotechniky Obzor *(Czechoslovakia)*

Elektrotech. Z.
Elektrotechnische Zeitschrift *(Germany)*

Elektrotech. Z. A.
Elektrotechnische Zeitschrift. A *(Germany)*

Elektrotekhnika
Elektrotekhnika (formerly Vestnik Elektropromyshlennosti) *(U.S.S.R.)*

Endeavour
*Endeavour *(England)*

Endocrinology
*Endocrinology *(U. S.)*

Endokrinologie
Endokrinologie *(Germany)*

Energetica (Bucharest)
Energetica (Bucharest) *(Romania)*

Energia Atomtech.
*Energia es Atomtechnika *(Hungary)*

Energie Nucl. (Madrid)
*Energia Nuclear (Madrid) *(Spain)*

Energie Nucl. (Milan)
*Energia Nucleare (Milan) *(Italy)*

Energie Nucl.
*Energie Nucleaire *(France)*

Energy Intern.
*Energy International *(England)*

Engineer
Engineer, The *(England)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. I
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series I *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. II
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series II *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. III
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series III *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. IV
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series IV *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. V
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series V *(U. S.)*

Engl. Abstr. Soviet Bloc Mainland China Tech. J. Ser. VI
*English Abstracts of Selected Articles from Soviet Bloc and Mainland China Technical Journals Series VI *(U. S.)*
Enka Biniru
Enka Biniru (Vinyl Japan) *(Japan)*
Enzymologia
Enzymologia *(Netherlands)*
Epitoanyag
Epitoanyag *(Hungary)*
Erekutoronikusu
Erekutoronikusu (Electronics (Japan)) *(Japan)*
Ergeb. Allgem. Pathol. Pathol. Anat.
*Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*
Ergeb. Exakt. Naturw.
Ergebnisse der Exakten Naturwissenschaften *(Germany)*
Ergeb. Med. Strahlenforsch.
Ergebnisse der Medizinischen Strahlenforschung *(Germany)*
Euphytica
Euphytica *(Netherlands)*
Euratom Bull.
*Euratom Bulletin (Bulletin of the European Atomic Energy Community) *(Netherlands)*
EuroNuclear
*EuroNuclear *(England)*
Evolution Med.
Evolution Medicale, L *(France)*
Excerpta Med. Intern. Congr. Ser.
Excerpta Medica. International Congres Series *(Netherlands)*
Excerpta Med., Sect. XXIII
*Excerpta Medica, Section XXIII *(Netherlands)*
Experientia
*Experientia *(Switzerland)*
Exptl. Cell Res.
*Experimental Cell Research *(U. S.)*
Exptl. Mol. Pathol.
*Experimental and Molecular Pathology *(U. S.)*
Exptl. Tech. Physik
*Experimentelle Technik der Physik *(Germany)*
FAPIG (Tokyo)
FAPIG (Tokyo) *(Japan)*
Farmakol. i Toksikol.
Farmakologiya i Toksikologiya† *(U.S.S.R.)*
Federation Proc.
*Federation Proceedings *(U. S.)*
Federation Proc., Transl. Suppl.
*Federation Proceedings, Translation Supplement *(U. S.)*
Fertility Sterility
Fertility and Sterility *(U. S.)*
Fiziol. Zh., Akad. Nauk Ukr. RSR
*Fiziologichnii Zhurnal, Akademiya Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Fiz.-Khim. Mekhan. Materialov
*Fiziko-Khimicheskaya Mekhanika Materialov *(Ukrainian S.S.R.)*
Fiz.-Khim. Osnovy Proizv. Stali, Akad. Nauk SSSR, Inst. Met., Tr. 6-oi Konf., Moscow, 1961
Fiziko-Khimicheskie Osnovy Proizvodstva Stali, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova, Trudy 6-oi Konferentsii po Fiziko-Khimicheskim Osnovam Proizvodstva Stali, [Moscow], 1961 (Pub. 1964) *(U.S.S.R.)*
Fiziol. Rast.
Fiziologiya Rastenii, Akademiya Nauk SSSR† *(U.S.S.R.)*
Fiz. Metal. i Metalloved.
*Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*
Fiz. Szemle
*Fizikai Szemle *(Hungary)*
Fiz. Tverd. Tela
Fizika Tverdogo Tela† *(U.S.S.R.)*
Foederation Europaeischer Gewaesserschutz, Informationsbl.
Foederation Europaeischer Gewaesserschutz (FEG), Informationsblatt *(Switzerland)*
Folia Biol. (Prague)
*Folia Biologica (Prague) *(Czechoslovakia)*
Folia Biol. (Warsaw)
*Folia Biologica (Warsaw) *(Poland)*
Folia Cardiol.
Folia Cardiologica *(Italy)*
Folia Clin. Intern.
*Folia Clinica Internacional *(Spain)*
Folia Endocrinol. (Rome)
Folia Endocrinologica (Rome) *(Italy)*
Folia Haematol. (Frankfurt)
*Folia Haematologica (Frankfurt) *(Germany)*
Folia Histochem. Cytochem.
Folia Histochemica et Cytochemica *(Poland)*
Folia Med. (Naples)
*Folia Medica (Naples) *(Italy)*
Folia Microbiol. (Prague)
Folia Microbiologica (Prague) *(Czechoslovakia)*
Folia Morphol.
*Folia Morphologica *(Poland)*
Folia Ophthalmol. Japon.
Folia Ophthalmologica Japonica
*see **Nippon Ganka Kiyo***
Food Cosmet. Toxicol.
Food and Cosmetics Toxicology *(England)*
Food Irradiation
*Food Irradiation *(France)*
Food Technol.
Food Technology *(U. S.)*
Forest Sci.
Forest Science *(U. S.)*
Fortschr. Chem. Forsch.
*Fortschritte der Chemischen Forschung *(Germany)*
Fortschr. Gebiete Roentgenstrahlen Nuklearmed.
*Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*
Fortschr. Physik
*Fortschritte der Physik *(Germany)*
Freiberger Forschungsh. B
Freiberger Forschungshefte. Reihe B *(Germany)*
Fruits (Paris)
Fruits (Paris) *(France)*
Fuji Elec. J.
Fuji Electric Journal
*see **Fuji Jiho***
Fuji Jiho
Fuji Jiho (Fuji Electric Journal) *(Japan)*
Fukuoka Acta Med.
Fukuoka Acta Medica
*see **Fukuoka Igaku Zasshi***
Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Funtai Oyobi Funmatsuyakin
Funtai Oyobi Funmatsuyakin (Journal of Japan Society of Powder Metallurgy) *(Japan)*
Gac. Ortoped. Traumatol.
*Gaceta Ortopedia y Traumatologia *(Mexico)*
Gamma Field Symp.
Gamma Field Symposia *(Japan)*
Gann
Gann *(Japan)*
Gan no Rinsho
Gan no Rinsho (Japanese Journal of Cancer Clinics) *(Japan)*
Gaz. Med. France
Gazette Medicale de France *(France)*
Gaz. Prom.
Gazovaya Promyshlennost *(U.S.S.R.)*
Gazz. Chim. Ital.
Gazzetta Chimica Italiana *(Italy)*
Geburtsh Frauenheilk.
*Geburtshilfe und Frauenheilkunde *(Germany)*
G.E.C.J. Sci. Tech.
*G. E. C. Journal of Science and Technology *(England)*
G.E.N. (Caracas)
*G.E.N. (Caracas) *(Venezuela)*
Gencho Hiroshima Igaku
*Gencho Hiroshima Igaku (The Hiroshima Medical Journal) *(Japan)*
Gen. Comp. Endocrinol.
*General and Comparative Endocrinology *(U. S.)*
Genet. Agrar.
Genetica Agraria *(Italy)*
Genetica
*Genetica *(Netherlands)*
Genetics
*Genetics *(U. S.)*
Genet. Polon.
*Genetica Polonica *(Poland)*

Genet. Res.
*Genetical Research *(England)*
Genie Chim.
Genie Chimique (Supplement mensuel a Chimie & Industrie) *(France)*
Genshikaku Kenkyu
Genshikaku Kenkyu *(Japan)*
Genshiryoku Hatsuden
Genshiryoku Hatsuden (Nuclear Power) *(Japan)*
Genshiryoku Kogyo
*Genshiryoku Kogyo (Nuclear Engineering) *(Japan)*
Geochim. Cosmochim. Acta
*Geochimica et Cosmochimica Acta *(England)*
Geokhimiya
*Geokhimiya† *(U.S.S.R.)*
Geol. Rudn. Mestorozhd.
Geologiya Rudnykh Mestorozhdenii, Akademiya Nauk SSSR *(U.S.S.R.)*
Geomagnetism Aeronomy (USSR) (English Transl.)
Geomagnetism and Aeronomy (USSR) (English Translation of Geomagnetizm i Aeronomiya) *(U. S.)*
Geomagnetizm i Aeronomiya
*Geomagnetizm i Aeronomiya† *(U.S.S.R.)*
Geophysics
*Geophysics *(U. S.)*
Geophys. J.
*Geophysical Journal *(England)*
Geriatrics
Geriatrics *(U. S.)*
Gerontol. Clin.
*Gerontologia Clinica *(Switzerland)*
Gerontologia
*Gerontologia *(Switzerland)*
Gesundh.-Ingr.
Gesundheits-Ingenieur *(Germany)*
Gifu Ika Daigaku Kiyo
Gifu Ika Daigaku Kiyo (Acta Scholae Medicinalis in Gifu) *(Japan)*
Gigiena i Sanit.
*Gigiena i Sanitariya *(U. S. S. R.)*
Gigiena Truda i Prof. Zabolevaniya
Gigiena Truda i Professional'nye Zabolevaniya *(U.S.S.R.)*
Gijutsu Kenkyusho Shoho
Gijutsu Kenkyusho Shoho (Journal of Technical Laboratory (Tokyo)) *(Japan)*
Ginecol. Obstet. Mex.
*Ginecologia y Obstetricia de Mexico *(Mexico)*
Giorn. Gerontol.
*Giornale di Gerontologia *(Italy)*
Giorn. Igiene Med. Prevent.
Giornale di Igiene e Medicina Preventiva *(Italy)*
Giorn. Ital. Chemioterapia
*Giornale Italiano di Chemioterapia *(Italy)*
Giorn. Ital. Chir.
Giornale Italiano di Chirurgia *(Italy)*
Giorn. Med. Mil.
Giornale di Medicina Militare *(Italy)*
Giorn. Microbiol.
*Gironale di Microbiologia *(Italy)*
Glas-Instr.-Tech.
Glas-Instrumenten-Technik *(Germany)*
Glasnik Mat.-Fiz. Astron., Ser. II
*Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*
Glass Technol.
Glass Technology *(England)*
Grasas Aceites (Seville, Spain)
Grasas y Aceites (Seville, Spain) *(Spain)*
Grundforbattring
Grundforbattring *(Sweden)*
Guy's Hosp. Rept.
*Guy's Hospital Reports *(England)*
Hautarzt
Hautarzt, Der *(Austria)*
Health Phys.
*Health Physics *(U. S.-England)*
Helv. Chim. Acta
*Helvetica Chimica Acta *(Switzerland)*
Helv. Chir. Acta
*Helvetica Chirurgica Acta *(Switzerland)*
Helv. Med. Acta
*Helvetica Medica Acta *(Switzerland)*
Helv. Paediat. Acta
*Helvetica Paediatrica Acta *(Switzerland)*
Helv. Phys. Acta
*Helvetica Physica Acta *(Switzerland)*
Hemera Zoa
Hemera Zoa *(Indonesia)*
Hereditas
*Hereditas *(Sweden)*
Heredity
Heredity *(England)*
High Temp. (USSR) (English Transl.)
*High Temperature (USSR) (English Translation of Teplofizika Vysokikh Temperatur) *(U. S.)*
Hi-hakai Kensa
Hi-hakai Kensa (Journal of N.D.I.) *(Japan)*
Hindustan Antibiot. Bull.
*Hindustan Antibiotics Bulletin *(India)*
Hippokrates (Stuttgart)
Hippokrates (Stuttgart) *(Germany)*
Hirosaki Igaku
*Hirosaki Igaku (The Hirosaki Medical Journal) *(Japan)*
Hirosaki Med. J.
Hirosaki Medical Journal, The
see **Hirosaki Igaku**
Hiroshima Igaku
Hiroshima Igaku (The Journal of the Hiroshima Medical Association) *(Japan)*
Hiroshima J. Med. Sci.
*Hiroshima Journal of Medical Sciences *(Japan)*
Hiroshima Med. J.
Hiroshima Medical Journal, The
see **Gencho Hiroshima Igaku**
Hitachi Hyoron
Hitachi Hyoron (Hitachi Review) *(Japan)*
Hitachi Rev.
Hitachi Review
see **Hitachi Hyoron**
Hitachi Zosen Giho
Hitachi Zosen Giho (The Hitachi Zosen Technical Review) *(Japan)*
Hitachi Zosen Tech. Rev.
Hitachi Zosen Technical Review, The
see **Hitachi Zosen Giho**
HNO
HNO. Beihefte zur Zeitschrift fuer Hals-, Nasen- und Ohrenheilkunde *(Germany)*
Hoshasen Kobunshi
*Hoshasen Kobunshi (Radiation Research on Polymers) *(Japan)*
Hospital (London)
Hospital (London) *(England)*
Hospitals
Hospitals *(U. S.)*
Ho Tsu K'o Hsueh
*Ho Tsu K'o Hsueh (Nuclear Science) *(China)*
Hua Hsueh Hsueh Pao
Hua Hsueh Hsueh Pao (Acta Chimica Sinica) *(China)*
Hua Hsueh Shih Chieh
Hua Hsueh Shih Chieh (Chemical World (Shanghai)) *(China)*
Hua Hseuh Tung Pao
*Hua Hseuh Tung Pao (Chemical Bulletin) *(China)*
Huaxue Tongbao
Huaxue Tongbao
see **Hua Hseuh Tung Pao**
Hutnicke Listy
Hutnicke Listy *(Czechoslovakia)*
Ibaraki Daigaku Nogakubu Gakujitsu Hokoku
Ibaraki Daigaku Nogakubu Gakujitsu Hokoku (Scientific Reports of the Faculty of Agriculture, Ibaraki University) *(Japan)*
Icarus
*Icarus. International Journal of the Solar System *(U.S.-Eng.)*
Ideggyogy. Szemle
Ideggyogyaszati Szemle *(Hungary)*
Idengaku Zasshi
*Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*
Idojaras
Idojaras *(Hungary)*
IEEE (Inst. Elec. Electron. Engrs.), Spectrum
*IEEE (Institute of Electrical and Electronics Engineers), Spectrum *(U. S.)*

IEEE (Inst. Elec. Electron. Engrs.), Trans. Commun. Electron.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Communication and Electronics *(U. S.)*

IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci.
*IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*

Igaku To Seibutsugaku
Igaku To Seibutsugaku (Medicine and Biology) *(Japan)*

Igiene Mod. (Parma)
Igiene Moderna, L'(Parma) *(Italy)*

Igiene Sanita Pubblica (Rome)
Igiene e Sanita Pubblica (Rome) *(Italy)*

Illinois Med. J.
Illinois Medical Journal *(U. S.)*

Immunology
*Immunology *(England)*

Ind. At.
*Industries Atomiques *(France)*

Ind. Electron.
Industrial Electronics incorporating Electronic Technology *(England)*

Ind. Eng. Chem.
*Industrial and Engineering Chemistry *(U. S.)*

Ind. Eng. Chem., Fundamentals
*Industrial & Engineering Chemistry, Fundamentals *(U. S.)*

Ind. Eng. Chem., Process Design Develop.
*Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*

Ind. Eng. Chem., Prod. Res. Develop.
*Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*

Indian Eastern Engr.
*Indian & Eastern Engineer, The (incorporating the Far Eastern Engineer and Indian & Eastern Motors) *(India)*

Indian J. Chem.
*Indian Journal of Chemistry *(India)*

Indian J. Child Health
*Indian Journal of Child Health, The *(India)*

Indian J. Exptl. Biol.
*Indian Journal of Experimental Biology *(India)*

Indian J. Genet. Plant Breeding
Indian Journal of Genetics & Plant Breeding *(India)*

Indian J. Med. Sci.
*Indian Journal of Medical Sciences *(India)*

Indian J. Phys.
*Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*

Indian J. Pure Appl. Phys.
*Indian Journal of Pure & Applied Physics *(India)*

Indian J. Radiol.
*Indian Journal of Radiology *(India)*

Indian J. Technol.
*Indian Journal of Technology (formerly Journal of Scientific and Industrial Research (India), Section D) *(India)*

Indian Minerals
*Indian Minerals *(India)*

Ind. Med. Surg.
Industrial Medicine and Surgery *(U. S.)*

Ind. Prod. Res.
Industrial Production Research
see Seisan-Kenkyu

Ind. Res.
*Industrial Research *(U. S.)*

Ingenieur (Utrecht)
Ingenieur, De (Utrecht) *(Netherlands)*

Ingenioren
Ingenioren *(Denmark)*

Ing. Nucl.
Ingegneria Nucleare *(Italy)*

Inorg. Chem.
*Inorganic Chemistry *(U. S.)*

Instr. Nucl. (Paris)
*Instrumentation Nucleaire (Paris). Supplement au Bulletin d'Informations Scientifiques et Techniques (Paris) *(France)*

Intern. Aerospace Abstr.
*International Aerospace Abstracts *(U. S.)*

Internal Med. (Tokyo)
Internal Medicine (Tokyo)
see Naika

Intern. Arch. Allergy Appl. Immunol.
*International Archives of Allergy and Applied Immunology *(Switzerland)*

Intern. Arch. Gewerbepathol. Gewerbehyg.
Internationales Archiv fuer Gewerbepathologie und Gewerbehygiene *(Germany)*

Intern. At. Energy Agency Bull.
*International Atomic Energy Agency Bulletin *(Austria)*

Intern. Chem. Eng.
International Chemical Engineering *(U. S.)*

Internist
Internist, Der *(Germany)*

Intern. J. Air Water Pollution
*International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*

Intern. J. Appl. Radiation Isotopes
*International Journal of Applied Radiation and Isotopes *(England)*

Intern. J. Electron.
*International Journal of Electronics (formerly Journal of Electronics and Control) *(England)*

Intern. J. Heat Mass Transfer
*International Journal of Heat and Mass Transfer *(England)*

Intern. J. Powder Met.
*International Journal of Powder Metallurgy *(U. S.)*

Intern. J. Radiation Biol.
*International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*

Intern. Rev. Cytol.
International Review of Cytology *(U. S.)*

Intern. Rev. Exptl. Pathol.
International Review of Experimental Pathology *(England)*

Intern. Sci. Technol.
*International Science and Technology *(U. S.)*

Intern. Union Geodesy Geophys. Monograph
International Union of Geodesy and Geophysics Monograph *(France)*

Inzh.-Fiz. Zh.
*Inzhenerno-Fizicheskii Zhurnal (formerly Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR) *(Belorussian S.S.R.)*

Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR
Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR *(Belorussian S.S.R.)*

ISA (Instr. Soc. Am.) Trans.
*ISA (Instrument Society of America) Transactions *(U. S.)*

Ishikawajima-Harima Eng. Rev.
Ishikawajima-Harima Engineering Review
see Ishikawajima-Harima Giho

Ishikawajima-Harima Giho
Ishikawajima-Harima Giho (Ishikawajima-Harima Engineering Review) *(Japan)*

Isotopes Radiation (Tokyo)
Isotopes and Radiation (Tokyo)
see Doitai To Hoshasen

Isotopes Radiation Technol.
*Isotopes and Radiation Technology (A Quarterly Technical Progress Review) *(U. S.)*

Israel J. Chem.
*Israel Journal of Chemistry (supersedes Bulletin of the Research Council of Israel, Section A: Chemistry) *(Israel)*

Israel J. Exptl. Med.
Israel Journal of Experimental Medicine (formerly Bulletin of the Research Council of Israel, Section E) *(Israel)*

Israel J. Phys.
*Israel Journal of Physics (supersedes in part Bulletin of the Research Council of Israel, Section F: Mathematics and Physics) *(Israel)*

Issled. po Zharoprock. Splavam, Akad. Nauk SSSR, Inst. Met.
*Issledovaniya po Zharoprochnym Splavam, Akademiya Nauk SSSR, Institut Metallurgii imeni A. A. Baikova *(U.S.S.R.)*

Istanbul Tek. Univ. Bul.
*Istanbul Teknik Universitesi Bulteni *(Turkey)*

Istanbul Univ., Fen Fak. Mecmuasi, Seri C
*Istanbul Universitesi Fen Fakultesi Mecmuasi: Seri C: Astronomi-Fizik-Kimya *(Turkey)*

IVA (Ingeniorsvetenskapsakad.) Medd.
IVA (Ingeniorsvetenskapsakademien) Meddelande *(Sweden)*

Iwate Daigaku Nogakubu Hokoku
Iwate Daigaku Nogakubu Hokoku (Journal of the Faculty of Agriculture, Iwate University) *(Japan)*

Iwate Igaku Zasshi
Iwate Igaku Zasshi (The Journal of the Iwate Medical Association) *(Japan)*

Izmeritel. Tekhn.
*Izmeritel'naya Tekhnika' *(U.S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Nauk Zemle
*Izvestiya Akademii Nauk Armyanskoi SSR, Nauk o Zemle *(Armenian S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk
*Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Biol. i Med. Nauk
Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Biologicheskikh i Meditsinskikh Nauk *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekhn. i Mat. Nauk
*Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Tekhnicheskikh i Matematicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk) *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Biol.
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Fiz. Mat. i Tekhn. Nauk
*Izvestiya Akademii Nauk Estonskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Estonskoi SSR, Seriya Tekhnicheskikh i Fiziko Matematicheskikh Nauk) *(Estonian S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Biologicheskikh Nauk (supersedes Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Botaniki i Pochvovedeniya) *(Kazakh S.S.R.)*

Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Kazakh S.S.R.)*

Izv. Akad. Nauk SSSR, Energ. i Transp.
*Izvestiya Akademii Nauk SSSR, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Fiz. Atm. i Okeana
*Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Fiz. Zemli
*Izvestiya Akademii Nauk SSSR, Fizika Zemli (supersedes in part Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskiya) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Mekhan. i Mashinostr.
*Izvestiya Akademii Nauk SSSR, Mekhanika i Mashinostroenie (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Metal.
*Izvestiya Akademii Nauk SSSR, Metally (formerly Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Met. i Gorn. Delo
Izvestiya Akademii Nauk SSSR, Metallurgiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Gornoe Delo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
*Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Fiz.
*Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geofiz.
Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Khim.
*Izvestiya Akademii Nauk SSSR, Seriya Khimicheskaya (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk
*Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Fiz. Inst. s Aneb, Bulgar. Akad. Nauk.
*Izvestiya na Fizicheskiya Institut s Aneb, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Inst. po Fiziol. Bulgar. Akad. Nauk.
Izvestiya na Instituta po Fiziologia, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Biol.-Med. Nauk
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Biologo-Meditsinskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Khimicheskikh Nauk *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Tekhn. Nauk.
*Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Seriya Tekhnicheskikh Nauk (supersedes in part Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR) *(U.S.S.R.)*

Izv. Timiryazev. Sel'skokhoz. Akad.
Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii *(U.S.S.R.)*

Izv. Tomsk. Politekhn. Inst.
Izvestiya Tomskogo Politekhnicheskogo Instituta imeni S. M. Kirova *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met.
Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Energ.
Izvestiya Vysshikh Uchebnykh Zavedenii, Energetika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Fiz.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol.
Izvestiya Vysshikh Uchebnykh Zavedenii, Khimiya i Khimicheskaya Tekhnologiya *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Radiofiz.
*Izvestiya Vysshikh Uchebnykh Zavednii, Radiofizika† *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met.
*Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metallurgiya *(U.S.S.R.)*

Jaderna Energie
*Jaderna Energie *(Czechoslovakia)*

J. Agr. Food Chem.
Journal of Agricultural and Food Chemistry *(U. S.)*

Jahresber. Deut. Wetterdienstes
*Jahresberichte des Deutschen Wetterdienstes *(Germany)*

J. Allergy
Journal of Allergy, The *(U.S.)*

J. Am. Ceram. Soc.
*Journal of the American Ceramic Society *(U. S.)*

J. Am. Chem. Soc.
*Journal of the American Chemical Society *(U. S.)*

J. Am. Dental Assoc.
Journal of the American Dental Association, The *(U. S.)*

J. Am. Geriat. Soc.
Journal of the American Geriatrics Society *(U. S.)*

J. Am. Med. Assoc.
Journal of the American Medical Association, The *(U. S.)*

J. Am. Med. Women's Assoc.
Journal of the American Medical Women's Association *(U. S.)*

J. Am. Oil Chemists' Soc.
Journal of the American Oil Chemists' Society, The *(U. S.)*

J. Am. Vet. Med. Assoc.
Journal of the American Veterinary Medical Association *(U. S.)*

J. Am. Water Works Assoc.
*Journal of the American Water Works Association *(U. S.)*

J. Animal Sci.
Journal of Animal Science *(U. S.)*

Japan Analyst
Japan Analyst
see Bunseki Kagaku

Japan. Arch. Internal Med.
Japanese Archives of Internal Medicine
see Naika Hokan

Japan. Circulation J. (English Ed.)
*Japanese Circulation Journal (English Edition) *(Japan)*

Japan. Heart J.
*Japanese Heart Journal *(Japan)*
Japan. J. Appl. Phys.
*Japanese Journal of Applied Physics *(Japan)*
Japan. J. Cancer Clin.
Japanese Journal of Cancer Clinics
see Gan no Rinsho
Japan. J. Chest Diseases
Japanese Journal of Chest Diseases, The
see Nippon Kyobu Rinsho
Japan. J. Clin. Hematol.
Japanese Journal of Clinical Hematology, The
see Rinsho Ketsueki
Japan. J. Genetics
Japanese Journal of Genetics
see Idengaku Zasshi
Japan. J. Human Genet.
Japanese Journal of Human Genetics
see Jinrui Idengaku Zasshi
Japan. J. Hyg.
Japanese Journal of Hygiene
see Nippon Eiseigaku Zasshi
Japan. J. Nutr.
Japanese Journal of Nutrition, The
see Eiyogaku Zasshi
Japan. J. Physiol.
Japanese Journal of Physiology, The *(Japan)*
Japan. J. Public Health
Japanese Journal of Public Health
see Nippon Koshu Eisei Zasshi
Japan. J. Urol.
Japanese Journal of Urology
see Nippon Hinyokika Gakkai Zasshi
Japan. J. Vet. Sci.
Japanese Journal of Veterinary Science
see Nippon Juigaku Zasshi
J. Appl. Chem. (London)
*Journal of Applied Chemistry (London) *(England)*
J. Appl. Mech.
*Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*
J. Appl. Meteorol.
*Journal of Applied Meteorology *(U. S.)*
J. Appl. Phys.
*Journal of Applied Physics *(U. S.)*
J. Appl. Physiol.
*Journal of Applied Physiology *(U. S.)*
J. Appl. Polymer Sci.
*Journal of Applied Polymer Science *(U. S.)*
J. Assoc. Offic. Agr. Chemists
*Journal of the Association of Official Agricultural Chemists *(U. S.)*
J. Assoc. Physicians India
Journal of the Association of the Physicians of India *(India)*
J. At. Energ. Soc. Japan
Journal of the Atomic Energy Society of Japan
see Nippon Genshiryoku Gakkaishi
J. Atherosclerosis Res.
Journal of Atherosclerosis Research *(Netherlands)*
J. Atmospheric Sci.
*Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*
J. Atmospheric Terrest. Phys.
*Journal of Atmospheric and Terrestrial Physics *(U. S.)*
J. Australian Inst. Metals
*Journal of the Australian Institute of Metals *(Australia)*
J. Bacteriol.
*Journal of Bacteriology *(U. S.)*
J. Basic Eng.
*Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*
J. Belge Radiol.
*Journal Belge de Radiologie *(Belgium)*
J. Biochem. (Tokyo)
Journal of Biochemistry, The (Tokyo) *(Japan)*
J. Biol. Chem.
*Journal of Biological Chemistry, The *(U. S.)*
J. Brasil. Neurol.
*Journal Brasileiro de Neurologia *(Brazil)*
J. Brasil. Psiquiat.
*Journal Brasileiro de Psiquiatria *(Brazil)*

J. Brit. Interplanet. Soc.
*Journal of the British Interplanetary Society *(England)*
J. Brit. Nucl. Energy Soc.
*Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*
J. Calif. State Dental Assoc.
Journal of the California State Dental Association, The *(U. S.)*
J. Can. Assoc. Radiologists
*Journal of the Canadian Association of Radiologists *(Canada)*
J. Can. Ceram. Soc.
*Journal of the Canadian Ceramic Society *(Canada)*
J. Cell Biol.
Journal of Cell Biology, The (formerly Journal of Biophysical and Biochemical Cytology) *(U. S.)*
J. Cellular Comp. Physiol.
*Journal of Cellular and Comparative Physiology *(U. S.)*
J. Ceram. Assoc. Japan
Journal of the Ceramic Association of Japan
see Yogyo Kyokai Shi
J. Chem. Educ.
Journal of Chemical Education *(U. S.)*
J. Chem. Eng. Data
*Journal of Chemical and Engineering Data *(U. S.)*
J. Chem. Phys.
*Journal of Chemical Physics, The *(U. S.)*
J. Chem. Soc.
*Journal of the Chemical Society (London) *(England)*
J. Chem. Soc. Japan
Journal of the Chemical Society of Japan
see Nippon Kagaku Zasshi
J. Chem. Soc. Japan, Ind. Chem. Sect.
Journal of the Chemical Society of Japan, Industrial Chemistry Section
see Kogyo Kagaku Zasshi
J. Chem. Soc. Japan, Pure Chem. Sect.
Journal of the Chemistry Society of Japan, Pure Chemistry Section
see Nippon Kagaku Zasshi
J. Chim. Phys.
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*
J. Chinese Chem. Soc. (Taiwan)
*Journal of the Chinese Chemical Society (Taiwan) *(China)*
J. Chir. (Paris)
Journal de Chirurgie (Paris) *(France)*
J. Chromatog.
*Journal of Chromatography *(Netherlands)*
J. Clay Res. Group Japan
Journal of the Clay Research Group of Japan *(Japan)*
J. Clin. Endrocrinol. Metab.
*Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*
J. Clin. Invest.
*Journal of Clinical Investigation, The *(U. S.)*
J. Clin. Pathol.
Journal of Clinical Pathology *(England)*
J. Coll. Radiologists Australasia
*Journal of the College of Radiologists of Australasia *(Australia)*
J. Dairy Sci.
Journal of Dairy Science *(U. S.)*
J. Dental Res.
Journal of Dental Research, The *(U. S.)*
J. Econ. Entomol.
Journal of Economic Entomology *(U. S.)*
J. Egypt. Med. Assoc.
*Journal of the Egyptian Medical Association, The *(Egypt)*
J. Electroanal. Chem.
*Journal of Electroanalytical Chemistry *(Netherlands)*
J. Electrochem. Soc.
*Journal of the Electrochemical Society *(U. S.)*
J. Electron. Control
Journal of Electronics and Control *(U. S.)*
J. Electronmicroscopy (Tokyo)
Journal of Electronmicroscopy (Tokyo) *(Japan)*
J. Embryol. Exptl. Morphol.
*Journal of Embryology and Experimental Morphology *(England)*
J. Eng. Power
*Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*
J. Exptl. Med.
*Journal of Experimental Medicine *(U. S.)*

J. Exptl. Zool.
Journal of Experimental Zoology *(U. S.)*

J. Fac. Agr., Iwate Univ.
Journal of the Faculty of Agriculture, Iwate University
see Iwate Daigaku Nogakubu Hokoku

J. Fac. Agr. Kyushu Univ.
Journal of the Faculty of Agriculture, Kyushu University *(Japan)*

J. Fac. Sci., Hokkaido Univ., Ser. II
Journal of the Faculty of Science, Hokkaido University Series II *(Japan)*

J. Fac. Sci., Hokkaido Univ., Ser. V
Journal of the Faculty of Science, Hokkaido University, Series V *(Japan)*

J. Fluid Mech.
*Journal of Fluid Mechanics *(U. S.)*

J. Food Sci.
Journal of Food Science (formerly Food Research) *(U. S.)*

J. Forensic Sci.
Journal of Forensic Sciences *(U. S.)*

J. Formosan Med. Assoc.
Journal of the Formosan Medical Association
see T'ai-wan I Hsueh Hui Tsa Chih

J. Franc. Med. Chir. Thorac.
Journal Francais de Medecine et Chirurgie Thoracique *(France)*

J. Gas Chromatog.
Journal of Gas Chromatography *(U. S.)*

J. Genet.
*Journal of Genetics *(U. S.)*

J. Gen. Microbiol.
Journal of General Microbiology *(England)*

J. Gen. Physiol.
Journal of General Physiology *(U. S.)*

J. Geol.
Journal of Geology, The *(U.S.)*

J. Geomagnet. Geoelec.
*Journal of Geomagnetism and Geoelectricity *(Japan)*

J. Geophys. Res.
*Journal of Geophysical Research *(U. S.)*

J. Gerontol.
*Journal of Gerontology *(U. S.)*

J. Heat Transfer
*Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*

J. Hiroshima Med. Assoc.
Journal of the Hiroshima Medical Association, The
see Hiroshima Igaku

J. Histochem. Cytochem.
Journal of Histochemistry and Cytochemistry, The *(U. S.)*

J. Hyg. Epidemiol. Microbiol. Immunol. (Prague)
Journal of Hygiene, Epidemiology, Microbiology, and Immunology (Prague) *(Czechoslovakia)*

Jibi Inko-ka
Jibi Inko-ka (Otolaryngology) *(Japan)*

Jikeikai Med. J.
*Jikeikai Medical Journal *(Japan)*

J. Immunol.
*Journal of Immunology, The *(U. S.)*

J. Indian Chem. Soc.
*Journal of the Indian Chemical Society *(India)*

J. Infect. Diseases
Journal of Infectious Diseases, The *(U. S.)*

J. Inorg. Nucl. Chem.
*Journal of Inorganic & Nuclear Chemistry *(England)*

Jinrui Idengaku Zasshi
Jinrui Idengaku Zasshi (Japanese Journal of Human Genetics) *(Japan)*

J. Insect Physiol.
Journal of Insect Physiology *(U.S.)*

J. Inst. Elec. Engrs. (London)
Journal of the Institution of Electrical Engineers (London), The *(England)*

J. Inst. Elec. Engrs. Japan
Journal of the Institute of Electric Engineers of Japan, The
see Denki Gakkai Zasshi

J. Inst. Engrs., Australia
*Journal of the Institution of Engineers, Australia *(Australia)*

J. Inst. Metals
*Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*

J. Inst. Petrol.
Journal of the Institute of Petroleum *(England)*

J. Invest. Dermatol.
Journal of Investigative Dermatology, The *(U. S.)*

J. Iowa State Med. Soc.
Journal of the Iowa State Medical Society, The *(U. S.)*

J. Iron Steel Inst. (London)
Journal of the Iron and Steel Institute (London) *(England)*

J. Iwate Med. Assoc.
Journal of the Iwate Medical Association, The
see Iwate Igaku Zasshi

J. Japan. Assoc. Petrol. Technologists
Journal of the Japanese Association of Petroleum Technologists
see Sekiyu Gijutsu Kyokaishi

J. Japan. Chem.
Journal of Japanese Chemistry
see Kagaku No Ryoiki

J. Japan Inst. Metals (Sendai)
Journal of the Japan Institute of Metals (Sendai)
see Nippon Kinzoku Gakkaishi

J. Japan. Obstet. Gynecol.
Journal of Japanese Obstetrics and Gynecology
see Nippon Sanka Fujinka Gakkai Zasshi

J. Japan. Obstet. Gynecol. Soc.
Journal of the Japanese Obstetrical and Gynecological Society (English edition of Nippon Sanfrejinka Zasshi) *(Japan)*

J. Japan Soc. Civil Engrs.
Journal of the Japan Society of Civil Engineers *(Japan)*

J. Japan. Soc. Food Nutr.
Journal of the Japanese Society of Food and Nutrition
see Eiyo To Shokuryo

J. Japan Welding Soc.
Journal of the Japan Welding Society
see Yosetsu Gakkaishi

J. Joint Panel Nucl. Marine Propulsion
*Journal of the Joint Panel on Nuclear Marine Propulsion *(England)*

J. Kentucky State Med. Assoc.
Journal of the Kentucky State Medical Association, The *(U. S.)*

J. Kumamoto Med. Soc.
Journal of the Kumamoto Medical Society, The
see Kumamoto Igakkai Zasshi

J. Lab. Clin. Med.
*Journal of Laboratory and Clinical Medicine, The *(U. S.)*

J. Less-Common Metals
*Journal of the Less-Common Metals *(Netherlands)*

J. Lipid Res.
Journal of Lipid Research *(U. S.)*

J. Marine Res. (Sears Found. Marine Res.)
Journal of Marine Research (Sears Foundation for Marine Research) *(U. S.)*

J. Math. Anal. Appl.
*Journal of Mathematical Analysis and Applications *(U. S.)*

J. Math. Phys. (N. Y.)
*Journal of Mathematical Physics (New York) *(U. S.)*

J. Mecan.
*Journal de Mecanique *(France)*

J. Mech. Eng. Sci.
Journal of Mechanical Engineering Science, The *(England)*

J. Med. Assoc. Georgia
Journal of the Medical Association of Georgia, The *(U. S.)*

J. Med. Chem.
Journal of Medicinal Chemistry *(U. S.)*

J. Med. Educ.
Journal of Medical Education, The *(U. S.)*

J. Med. Pharm. Chem.
Journal of Medicinal and Pharmaceutical Chemistry *(U. S.)*

J. Med. Soc. New Jersey
Journal of the Medical Society of New Jersey *(U. S.)*

J. Metals
*Journal of Metals *(U. S.)*

J. Meteorol.
*Journal of Meteorology, The *(U. S.)*

J. Mining Met. Inst. Japan
Journal of Mining and Metallurgical Institute of Japan
see Nippon Kogyo Kaishi

J. Mol. Biol.
*Journal of Molecular Biology *(England)*

J. Mol. Spectry.
*Journal of Molecular Spectroscopy *(U. S.)*

J. Nagasaki Med. Assoc.
Journal of the Nagasaki Medical Association
see Nagasaki Igakkai Zasshi

J. Natl. Cancer Inst.
*Journal of the National Cancer Institute *(U. S.)*

J. Natl. Res. Council Thailand
*Journal of the National Research Council of Thailand (contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*

J. Nat. Sci. Math.
*Journal of Natural Sciences and Mathematics *(Pakistan)*

J. N. D. I. (Japan)
Journal of N. D. I. (Japan)
see Hi-hakai Kensa

J. Neurochem.
Journal of Neurochemistry *(England)*

J. Neuropathol. Exptl. Neurol.
Journal of Neuropathology and Experimental Neurology, The *(U. S.)*

J. Neurosurg.
Journal of Neurosurgery *(U. S.)*

J. Nippon Med. School
Journal of the Nippon Medical School, The
see Nippon Ika Daigaku Zasshi

J. Nucl. Energy: Pt. A & B
*Journal of Nuclear Energy: Parts A & B. Reactor Science and Technology (formerly issued separately) *(England)*

J. Nucl. Energy: Pt. C
*Journal of Nuclear Energy: Part C. Plasma Physics–Accelerators–Thermonuclear Research *(England)*

J. Nucl. Mater.
*Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*

J. Nucl. Med.
*Journal of Nuclear Medicine *(U. S.)*

J. Nucl. Sci. Technol. (Tokyo)
*Journal of Nuclear Science and Technology (Tokyo) *(Japan)*

J. Nutr.
Journal of Nutrition, The *(U. S.)*

J. Occupational Med.
Journal of Occupational Medicine *(U. S.)*

J. Okayama Med. Soc.
Journal of Okayama Medical Society
see Okayama Igakkai Zasshi

J. Opt. Soc. Am.
*Journal of the Optical Society of America *(U. S.)*

J. Oral Therap. Pharmacol.
Journal of Oral Therapeutics and Pharmacology *(U. S.)*

J. Organometal. Chem. (Amsterdam)
Journal of Organometallic Chemistry (Amsterdam) *(Netherlands)*

J. Org. Chem.
*Journal of Organic Chemistry, The *(U. S.)*

J. Osaka City Med. Center
Journal of the Osaka City Medical Center, The
see Osaka Shiritsu Daigaku Igaku Zasshi

J. Parasitol.
Journal of Parasitology, The *(U. S.)*

J. Pathol. Bacteriol.
Journal of Pathology and Bacteriology, The *(Scotland)*

J. Pharmacol. Exptl. Therap.
Journal of Pharmacology and Experimental Therapeutics, The *(U. S.)*

J. Pharm. Pharmacol.
Journal of Pharmacy and Pharmacology *(England)*

J. Pharm. Sci.
Journal of Pharmaceutical Sciences *(U. S.)*

J. Pharm. Soc. Japan
Journal of the Pharmaceutical Society of Japan
see Yakugaku Zasshi

J. Phys. (Paris)
*Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*

J. Phys. Chem.
*Journal of Physical Chemistry, The *(U. S.)*

J. Phys. Chem. Solids
*Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(U. S.)*

J. Phys., Phys. Appl. (Paris)
*Journal de Physique, Physique Applique (Paris). Supplement au Journal de Physique (Paris) *(France)*

J. Phys. Soc. Japan
*Journal of the Physical Society of Japan *(Japan)*

J. Phot. Sci.
Journal of Photographic Science *(England)*

J. Polarog. Soc.
Journal of the Polarographic Society *(England)*

J. Polymer Sci. Pt. A
*Journal of Polymer Science. Part A: General Papers *(U. S.)*

J. Polymer Sci. Pt. B
*Journal of Polymer Science. Part B: Polymer Letters *(U. S.)*

J. Polymer Sci. Pt. C
*Journal of Polymer Science. Part C: Polymer Symposia *(U. S.)*

J. Prakt. Chem.
Journal fuer Praktische Chemie *(Germany)*

J. Protozool.
Journal of Protozoology, The *(U. S.)*

J. Quant. Spectry. Radiative Transfer
*Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*

J. Radiation Res. (Japan)
*Journal of Radiation Research *(Japan)*

J. Radiol., Electrol. Med. Nucl.
*Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*

J. Reprod. Fertility
Journal of Reproduction and Fertility *(England)*

J. Res. Inst. Catalysis, Hokkaido Univ.
*Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*

J. Res. Natl. Bur. Std., A
*Journal of Research of the National Bureau of Standards, A *(U. S.)*

J. Res. Natl. Bur. Std., B
*Journal of Research of the National Bureau of Standards, B *(U. S.)*

J. Res. Natl. Bur. Std., D
*Journal of Research of the National Bureau of Standards, D *(U. S.)*

J. Reticuloendothelial Soc.
*Journal of the Reticuloendothelial Society *(U. S.)*

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Roy. Inst. Public Health Hyg.
Journal of the Royal Institute of Public Health and Hygiene, The *(England)*

J. Roy. Naval Med. Serv.
Journal of the Royal Naval Medical Service *(England)*

J. S. African Chem. Inst.
Journal of the South African Chemical Institute *(S. Africa)*

J. Sci. Food Agr.
*Journal of the Science of Food and Agriculture *(England)*

J. Sci. Hiroshima Univ. Ser. A-II
*Journal of Science of the Hiroshima University. Series A-II *(Japan)*

J. Sci. Ind. Res. (India)
*Journal of Scientific and Industrial Research *(India)*

J. Sci. Instr.
*Journal of Scientific Instruments *(England)*

J. Sci. Res. Banaras Hindu Univ.
Journal of Scientific Research of the Banaras Hindu University, The *(India)*

J. Sericult. Sci. Japan
Journal of Sericultural Science of Japan
see Nippon Sanshigoku Zasshi

J. Soc. Ind. Appl. Math.
Journal of the Society of Industrial and Applied Mathematics *(U.S.)*

J. Soc. Instr. Control Engrs. (Tokyo)
Journal of the Society of Instrument and Control Engineers (Tokyo)
see Keisoku To Seigyo

J. Spacecraft Rockets
Journal of Spacecraft and Rockets *(U. S.)*

J. Surg. Res.
Journal of Surgical Research *(U. S.)*

J. Tech. Lab. (Tokyo)
Journal of Technical Laboratory (Tokyo)
see Gijutsu Kenkyusho Shoho

J. Tenn. Acad. Sci.
*Journal of the Tennessee Academy of Science *(U. S.)*

J. Theoret. Biol.
*Journal of Theoretical Biology *(England)*

J. Thoracic Cardiovascular Surg.
Journal of Thoracic and Cardiovascular Surgery *(U. S.)*

J. Trauma
Journal of Trauma *(U. S.)*

J. Ultrastruct. Res.
*Journal of Ultrastructure Research *(U. S.)*

J. Urol.
Journal of Urology, The *(U. S.)*

J. Vacuum Sci. Technol.
*Journal of Vacuum Science and Technology, The *(U. S.)*

J. Water Pollution Control Federation
Journal of the Water Pollution Control Federation (formerly Sewage and Industrial Wastes) *(U. S.)*

J. Water Waste (Tokyo)
Journal of Water and Waste (Tokyo)
see Yosui To Haisui

J. Waterways Harbors Div., Am. Soc. Civil Engrs.
Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

Kagaku (Kyoto)
Kagaku (Kyoto) (Chemistry) *(Japan)*

Kagaku Kogaku
Kagaku Kogaku (Chemical Engineering) *(Japan)*

Kagaku Kogyo
Kagaku Kogyo (Chemical Industry) *(Japan)*

Kagaku No Ryoiki
Kagaku No Ryoiki (Journal of Japanese Chemistry) *(Japan)*

Kagaku to Kogyo (Tokyo)
Kagaku to Kogyo (Tokyo) (Chemistry and Chemical Industry) *(Japan)*

Kakuyugo-Kenkyu
Kakuyugo-Kenkyu *(Japan)*

Kauchuk i Rezina
Kauchuk i Rezina† *(U.S.S.R.)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kernenergie
*Kernenergie *(Germany)*

Kerntechnik
*Kerntechnik, Isotopentechnik und -Chemie *(Germany)*

KFKI Kozlemen.
KFKI Kozlemenyei
see Mag. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd.
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-fysiske Meddelelser *(Denmark)*

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Skrifter
*Kongelige Danske Videnskabernes Selskab, Det, Matematisk-Fysiske Skrifter *(Denmark)*

Kgl. Norske Vidensk. Selskabs, Forh.
*Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*

Khim. i Neft. Mashinostr.
Khimicheskoe i Neftyanoe Mashinostroenie *(U.S.S.R.)*

Khim. i Tekhnol. Topliv i Masel
Khimiya i Tekhnologiya Topliv i Masel *(U.S.S.R.)*

Khim. Volokna
Khimicheskie Volokna *(U.S.S.R.)*

Kibernetika
*Kibernetika *(Ukrainian S.S.R.)*

Kinetika i Kataliz
*Kinetika i Kataliz† *(U.S.S.R.)*

Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku
Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku (Report of National Research Institute for Metals) *(Japan)*

Kitakanto Igaku
Kitakanto Igaku (Kitakanto Medical Journal) *(Japan)*

Kitakanto Med. J.
Kitakanto Medical Journal
see Kitakanto Igaku

Klinich. Med.
Klinicheskaya Meditsina *(U.S.S.R.)*

Klin. Med. (Vienna)
Klinische Medizin (Vienna) *(Austria)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(Germany)*

Klin. Wochschr.
*Klinische Wochenschrift *(Germany)*

Kobe J. Med. Sci.
Kobe Journal of the Medical Sciences, The *(Japan)*

Kobe Steel Works Eng. Rept.
Kobe Steel Works Engineering Reports *(Japan)*

Kobunshi Kagaku
Kobunshi Kagaku (Chemistry of High Polymers) *(Japan)*

Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku
Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku (Report of the Fermentation Research Institute) *(Japan)*

Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku
Kogyo Gijutsuin Sen'i Kogyo Shikensho Kenkyu Hokoku (Bulletin of the Textile Research Institute of Japanese Government) *(Japan)*

Kogyo Kagaku Zasshi
Kogyo Kagaku Zasshi (Journal of the Chemical Society of Japan, Industrial Chemistry Section) *(Japan)*

Kohasz. Lapok
Kohaszati Lapok *(Hungary)*

K'o Hsueh T'ung Pao
*K'o Hsueh T'ung Pao (Scientia) *(China)*

Kolloidn. Zh.
Kolloidnyi Zhurnal† *(U.S.S.R.)*

Kolloid-Z.
Kolloid-Zeitschrift *(Germany)*

Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B.
*Koninklijke Nederlandse Akademie van Wetenschappen, Proceedings, Series B *(Netherlands)*

Konserv. i Ovoshchesushil. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

Korean J. Internal Med.
Korean Journal of Internal Medicine, The *(Korea)*

Korean J. Zool.
Korean Journal of Zoology, The *(Korea)*

Koshu Eiseiin Kenkyu Hokoku
Koshu Eiseiin Kenkyu Hokoku (Bulletin of the Institute of Public Health) *(Japan)*

Kosmich. Issled.
*Kosmicheskie Issledovaniya *(U.S.S.R.)*

Kosmos (Warsaw) Ser. A
*Kosmos (Warsaw) Seria A: Biologia *(Poland)*

Kristallografiya
Kristallografiya† *(U.S.S.R.)*

Krupp Tech. Rev. (English Transl. Tech. Mitt. Krupp, Werksber.)
*Krupp Technical Review (English Translation of Technische Mitteilungen Krupp, Werksberichte) *(Germany)*

Kulturpflanze
Kulturpflanze, Die *(Germany)*

Kumamoto Igakkai Zasshi
Kumamoto Igakkai Zasshi (The Journal of the Kumamoto Medical Society) *(Japan)*

K'un Ch'ung Hsueh Pao
K'un Ch'ung Hsueh Pao (Acta Entomologica Sinica) *(China)*

Kwart. Geol.
*Kwartalnik Geologiczny *(Poland)*

Kyushu J. Med. Sci.
Kyushu Journal of Medical Science *(Japan)*

Lab. Animal Care
Laboratory Animal Care *(U. S.)*

Lab. Invest.
Laboratory Investigation *(U. S.)*

Lancet
Lancet, The *(England)*

Landwirtsch. Forsch.
Landwirtschaftliche Forschung *(Germany)*

Lantbrukshogskol. Ann.
Lantbrukshogskolans Annaler *(Sweden)*

Laryngoscope
Laryngoscope, The *(U. S.)*

Lattante
Lattante, Il *(Italy)*

Latvijas PSR Zinatnu Akad. Vestis
*Latvijas PSR Zinatnu Akademijas Vestis *(Latvian S.S.R.)*

Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser.
*Latvijas PSR Zinatnu Akademijas Vestis, Fizikas un Teknisko Zinatnu Serija *(Latvian S.S.R.)*

Lectures Many-Body Probl.
Lectures on the Many-Body Problem *(U. S.)*

Leder
Leder, Das *(Germany)*
Leech
Leech *(S. Africa)*
Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos
*Lietuvos Fizikos Rinkinys, Lietuvos TSR Mokslu Akademija, Lietuvos TSR Aukstosios Mokyklos *(Lithuanian S.S.R.)*
Lietuvos TSR Mokslu Akad. Darbai, Ser. B
*Lietuvos TSR Mokslu Akademija Darbai: Serija B *(Lithuanian S.S.R.)*
Life Sci.
Life Sciences *(U. S.)*
Light Metal Age
Light Metal Age *(U. S.)*
Light Metals
Light Metals *(England)*
Lille Med.
*Lille Medical *(France)*
Limnol. Oceanog.
*Limnology and Oceanography *(U. S.)*
Litovsk. Mat. Sb.
*Litovskii Matematicheskikh Sbornik *(Lithuanian S.S.R.)*
Lodz. Towarz. Nauk, Wydzial III, Acta Chim.
*Lodzkie Towarzystwo Naukowe, Wydzial III, Acta Chimica *(Poland)*
Machinery Lloyd
*Machinery Lloyd *(England)*
Madjalah Inst. Tekn. Bandung Proc.
*Madjalah Institut Teknologi Bandung Proceedings *(Indonesia)*
Magy. Allatorv. Lapja
Magyar Allatorvosok Lapja *(Hungary)*
Magy. Fiz. Folyoirat
*Magyar Fizikai Folyoirat *(Hungary)*
Magy. Kem. Folyoirat
*Magyar Kemiai Folyoirat *(Hungary)*
Magy. Kem. Lapja
*Magyar Kemikusok Lapja *(Hungary)*
Magy. Radiol.
*Magyar Radiologia *(Hungary)*
Magy. Tud. Akad. At. Kut. Int. (Debrecen). Kozlemen.
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek
see At. Kozlemen.
Magy. Tud. Akad. Biol. Tud. Oszt. Kozlemen.
Magyar Tudomanyos Akademia Biologia Tudomanyok Osztalyanak Kozlemenyei, A *(Hungary)*
Magy. Tud. Akad. Kem. Tud. Oszt. Kozlemen.
Magyar Tudomanyos Akademia, Kemiai Tudomanyok Osztalyanak, Kozlemenyei, A *(Hungary)*
Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.
*Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei *(Hungary)*
Magy. Tud. Akad. Muszaki Tud. Oszt. Kozlemenyei
*Magyar Tudomanyos Akademia Muszaki Tudomanyok Osztalyanak Kozlemenyei *(Hungary)*
Mal. Cardiovascolari
*Malattie Cardiovascolari *(Italy)*
Maroc. Med.
Marco Medical *(Morocco)*
Mass Spectry. (Tokyo)
Mass Spectroscopy (Tokyo)
see Shitsuryo Bunseki
Mater. Design Eng.
*Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*
Mater. Evaluation
*Materials Evaluation (formerly Nondestructive Testing) *(U. S.)*
Materialy po Toksikol. Radioaktivn. Veshchestv, Akad. Med. Nauk SSSR
Materialy po Toksikologii Radioaktivnykh Veshchestv, Akademiya Meditsinskikh Nauk SSSR *(U.S.S.R.)*
Mater. Res. Std.
*Materials Research & Standards (Formerly ASTM (American Society for Testing Materials) Bulletin) *(U. S.)*
Mech. Eng.
Mechanical Engineering *(U. S.)*
Med. Ann. District Columbia
Medical Annals of the District of Columbia *(U. S.)*
Med. Biol. (Tokyo)
Medicine and Biology (Tokyo)
see Igaku To Seibutsugaku
Med. Bull. U. S. Army, Europe
Medical Bulletin of the U. S. Army, Europe
Med. Clin. N. Am.
Medical Clinics of North America, The *(U. S.)*
Med. Doswiadczalna Mikrobiol.
*Medycyna Doswiadczalna i Mikrobiologia *(Poland)*
Med. Exptl.
*Medicina Experimentalis *(Switzerland)*
Med. Glasnik
*Medicinski Glasnik *(Yugoslavia)*
Medicamundi
*Medicamundi *(Netherlands)*
Medicina (Mex.)
*Medicina *(Mexico)*
Med. Interna
Medicina Interna *(Romania)*
Med. J. Hiroshima Univ.
*Medical Journal of Hiroshima University *(Japan)*
Med. J. Malaya
*Medical Journal of Malaya, The *(Malaya)*
Med. J. Shinshu Univ.
*Medical Journal of Shinshu University *(Japan)*
Med. Klin. (Munich)
Medizinische Klinik (Munich) *(Germany)*
Med. Monatsschr.
Medizinische Monatsschrift *(Germany)*
Med. Pracy
*Medycyna Pracy *(Poland)*
Med. Radiol.
*Meditsinskaya Radiologiya† *(U.S.S.R.)*
Med. Serv. J. (Can.)
Medical Service Journal *(Canada)*
Med. Times
Medical Times *(U. S.)*
Med. Welt
Medizinsche Welt, Die *(Germany)*
Med. Weteryner. (Poland)
Medycyna Weterynaryjna *(Poland)*
Med. Zh. Uzbekistana
Meditsinskii Zhurnal Uzbekistana *(Uzbek S.S.R.)*
Meidensha Jiho
Meidensha Jiho (Meidensha Review) *(Japan)*
Meidensha Rev.
Meidensha Review
see Meidensha Jiho
Mem. Acad. Roy. Med. Belg.
*Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*
Mem. Actividades Desarrolladas Patronato "Juan de la Cierva" Invest. Tec., Consejo Super. Invest. Cient.
*Memoria de las Actividades Desarrolladas por el Patronato "Juan de la Cierva" de Investigacion Tecnica, Consejo Superior de Investigaciones Cientificas *(Spain)*
Mem. Coll. Sci., Univ. Kyoto, Ser. B
*Memoirs of the College of Science, University of Kyoto, Series B *(Japan)*
Mem. Fac. Eng., Kyoto Univ.
Memoirs of the Faculty of Engineering, Kyoto University *(Japan)*
Mem. Fac. Liberal Arts Educ., Yamanashi Univ.
Memoirs of the Faculty of Liberal Arts and Education, Yamanashi University *(Japan)*
Mem. Inst. Sci. Ind. Res. Osaka Univ.
Memoirs of the Institute of Scientific and Industrial Research, Osaka University *(Japan)*
Mem. Kakioka Magnetic Obs.
Memoirs of the Kakioka Magnetic Observatory
see Chijiki Kensokujo Yoho
Mem. Muroran Univ. Eng.
Memoirs of the Muroran University of Engineering
see Muroran Kogyo Daigaku Kenkyu Kokoku
Mem. Roy. Astron. Soc.
Memoirs of the Royal Astronomical Society *(England)*
Mem. School Sci. Eng., Waseda Univ.
Memoirs of the School of Science & Engineering, Waseda University (formerly Memoirs of the Faculty of Science & Engineering, Waseda University, Tokyo, Japan) *(Japan)*

Mem. Sci. Rev. Met.
*Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*
Mem. Soc. Roy. Sci. Liege
*Memoires de la Societe Royale des Sciences de Liege *(Belgium)*
Mem. Soc. Vaudoise Sci. Nat.
*Memoires de la Societe Vaudoise des Sciences Naturelles *(Switzerland)*
Meres es Automat.
Meres es Automatika *(Hungary)*
Mesures Controle Ind.
Mesures et Controle Industriel *(France)*
Metab., Clin. Exptl.
Metabolism, Clinical and Experimental *(U. S.)*
Metal Ind. (London)
Metal Industry, The (London) *(England)*
Metall
*Metall *(Germany)*
Metalloved. i Term. Obrabotka Metal.
*Metallovedenie i Termicheskaya Obrabotka Metallov† (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*
Metall-Reinig. Vorbehandl.
Metall-Reinigung & Vorbehandlung *(Germany)*
Metallurgia
*Metallurgia *(England)*
Metal Progr.
*Metal Progress *(U. S.)*
Metals Eng. Quart.
*Metals Engineering Quarterly *(U. S.)*
Metanioreba Tekhn.
Metanioreba da Tekhnika *(Georgian S.S.R.)*
Metaux (Corrosion-Ind.)
*Metaux (Corrosion-Industries) *(France)*
Methods Inform. Med.
Methods of Information in Medicine (supersedes Medical Documentation) *(Germany)*
Met. i Metalloved. Chistykh Metal., Sb. Nauchn. Rabot
Metallurgiya i Metallovedenie Chistykh Metallov, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Nauchnykh Rabot *(U.S.S.R.)*
Met. Ital.
*Metallurgia Italiana, La *(Italy)*
Met. Rev.
*Metallurgical Reviews *(England)*
Metrologia
Metrologia *(Germany)*
Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept. Ser.
Metallurgical Society, American Institute of Mining, Metallurgical and Petroleum Engineers, Institute of Metals Division, Special Report Series *(U. S.)*
Microchem. J.
*Microchemical Journal *(U. S.)*
Mikrobiologiya
Mikrobiologiya† *(U.S.S.R.)*
Mikrochim. Acta
Mikrochimica Acta *(Austria)*
Mikrochim. Ichnoanal. Acta
*Mikrochimica et Ichnoanalytica Acta (formerly Mikrochimica Acta) *(Austria)*
Minerva Dermatol.
Minerva Dermatologica *(Italy)*
Minerva Fisioterap.
Minerva Fisioterapica *(Italy)*
Minerva Ginecol.
Minerva Ginecologica *(Italy)*
Minerva Med.
Minerva Medica *(Italy)*
Minerva Nucl.
*Minerva Nucleare *(Italy)*
Minerva Ortoped.
Minerva Ortopedica *(Italy)*
Minerva Radiol., Fisioterap. Radiobiol.
*Minerva Radiologica, Fisioterapica e Radiobiologica *(Italy)*
Mining Can.
*Mining in Canada (formerly Precambrian) *(Canada)*
Mining Safety (Japan)
Mining and Safety (Japan)
see **Saiko To Hoan**

Missili
Missili *(Italy)*
Mitsubishi Denki Lab. Rept.
Mitsubishi Denki Laboratory Reports *(Japan)*
Mitsubishi Heavy Ind. Tech. Rev.
Mitsubishi Heavy Industries Technical Review *(Japan)*
Mitteilungsbl. Strahlungsmessgeraete
*Mitteilungsblaetter Strahlungsmessgeraete *(Germany)*
Mitt. Oesterr. Sanitaetsverwalt.
Mitteilungen der Oesterreichen Sanitaetsverwaltung *(Austria)*
Mizushori Gijutsu
Mizushori Gijutsu *(Japan)*
Mod. Castings
Modern Castings (includes New Technology Section) *(U. S.)*
Mod. Castings, New Technol. Sect.
Modern Castings, New Technology Section (included in Modern Castings) *(U. S.)*
Mod. Metals
Modern Metals *(U. S.)*
Mod. Power Eng.
*Modern Power and Engineering *(Canada)*
Mol. Phys.
*Molecular Physics *(U. S.)*
Monatsber. Deut. Akad. Wiss. Berlin
*Monatsberichte der Deutschen Akademie der Wissenschaften su Berlin *(Germany)*
Monatsh. Chem.
Monatshefte fuer Chemie und Verwandte Teile Anderer Wissenschaften *(Austria)*
Monatsschr. Kinderheilk.
Monatsschrift fuer Kinderheilkunde *(Germany)*
Monthly Notices Roy. Astron. Soc.
*Monthly Notices of the Royal Astronomical Society *(England)*
Montpellier Med.
*Montpellier Medical *(France)*
Muench. Med. Wochschr.
Muenchener Medizinische Wochenschrift *(Germany)*
Muroran Kogyo Daigaku Kenkyu Hokoku
Muroran Kogyo Daigaku Kenkyu Hokoku (Memoirs of the Muroran University of Engineering) *(Japan)*
Mutation Res.
Mutation Research *(Netherlands)*
Mutech Chem. Eng. J.
Mutech Chemical Engineering Journal *(England)*
Nagasaki Igakkai Zasshi
Nagasaki Igakkai Zasshi (Journal of the Nagasaki Medical Association) *(Japan)*
Nagoya Kogyo Gijutsu Shikensho Hokoku
Nagoya Kogyo Gijutsu Shikensho Hokoku (Reports of the Government Industrial Research Institute, Nagoya) *(Japan)*
Nahrung
Nahrung, Die *(Germany)*
Naika
Naika (Internal Medicine (Tokyo)) *(Japan)*
Naika Hokan
Naika Hokan (Japanese Archives of Internal Medicine) *(Japan)*
Natl. Cancer Inst. Monograph
National Cancer Institute Monograph *(U. S.)*
Natl. Inst. Animal Health Quart.
*National Institute of Animal Health Quarterly (Tokyo) *(Japan)*
Natl. Tech. Rept. (Matsushita Elec. Ind. Co., Osaka)
National Technical Report (Matsushita Electric Industrial Co., Osaka) *(Japan)*
Natura, Ser. Biol.
Natura, Seria Biologie *(Romania)*
Nature
*Nature (London) *(England)*
Naturwissenschaften
*Naturwissenschaften, Die *(Germany)*
Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki
Nauchnye Doklady Vysshei Shkoly, Biologicheskie Nauki *(U.S.S.R.)*
Nauchn. Tr. Visshiya Med. Inst., Sofiya
Nauchni Trudov na Visshiya Meditsinski Institut, Sofiya *(Bulgaria)*
Nauka i Zhittya
Nauka i Zhittya *(Ukrainian S.S.R.)*
NEC Res. Develop.
NEC Research and Development *(Japan)*

Ned. Tijdschr. Natuurk.
*Nederlands Tijdschrift voor Natuurkunde *(Netherlands)*
Neftekhimiya
Neftekhimiya *(U.S.S.R.)*
Neoplasma
*Neoplasma *(Czechoslovakia)*
Nepegeszsegugy
Nepegeszsegugy *(Hungary)*
Neue Huette
Neue Huette *(Germany)*
Neue Physik
Neue Physik *(Austria)*
Neue Tech.
*Neue Technik *(Switzerland)*
Neurology
Neurology *(U. S.)*
Neuropsichiatria
Neuropsichiatria *(Italy)*
New Engl. J. Med.
New England Journal of Medicine, The *(U. S.)*
New Scientist
*New Scientist, The *(England)*
New Zealand Med. J.
New Zealand Medical Journal, The *(New Zealand)*
Nippon Acta Radiol.
Nippon Acta Radiologica
see *Nippon Igaku Hoshasen Gakkai Zasshi*
Nippon Butsuri Gakkaisi
Nippon Butsuri Gakkaisi (Proceedings of the Physical Society of Japan) *(Japan)*
Nippon Eiseigaku Zasshi
Nippon Eiseigaku Zasshi (Japanese Journal of Hygiene) *(Japan)*
Nippon Ganka Gakkai Zasshi
Nippon Ganka Gakkai Zasshi (Acta Societatis Ophthalmologicae Japonicae) *(Japan)*
Nippon Ganka Kiyo
Nippon Ganka Kiyo (Folia Ophthalmologica Japonica) *(Japan)*
Nippon Genshiryoku Gakkaishi
*Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*
Nippon Hinyokika Gakkai Zasshi
Nippon Hinyokika Gakkai Zasshi (Japanese Journal of Urology) *(Japan)*
Nippon Hoshasen Gijutsu Gakkai Zasshi
Nippon Hoshasen Gijutsu Gakkai Zasshi (Japanese Journal of Radiological Technology) *(Japan)*
Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo
*Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo (Annual Report of the Japanese Association for Radiation Research on Polymers) *(Japan)*
Nippon Igaku Hoshasen Gakkai Zasshi
Nippon Igaku Hoshasen Gakkai Zasshi (Nippon Acta Radiologica) *(Japan)*
Nippon Ika Daigaku Zasshi
Nippon Ika Daigaku Zasshi (The Journal of the Nippon Medical School) *(Japan)*
Nippon Juigaku Zasshi
Nippon Juigaku Zasshi (Japanese Journal of Veterinary Science) *(Japan)*
Nippon Kagaku Zasshi
*Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*
Nippon Ketsueki Gakkai Zasshi
Nippon Ketsueki Gakkai Zasshi (Acta Haematologica Japonica) *(Japan)*
Nippon Kikai Gakkai Rombunshu
Nippon Kikai Gakkai Rombunshu (Transactions of the Japan Society of Mechanical Engineers) *(Japan)*
Nippon Kinzoku Gakkaishi
*Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai)) *(Japan)*
Nippon Kogyo Kaishi
Nippon Kogyo Kaishi (Journal of the Mining and Metallurgical Institute of Japan) *(Japan)*
Nippon Koshu Eisei Zasshi
Nippon Koshu Eisei Zasshi (Japanese Journal of Public Health) *(Japan)*
Nippon Kyobu Rinsho
Nippon Kyobu Rinsho (The Japanese Journal of Chest Diseases) *(Japan)*
Nippon Sanka Fujinka Gakkai Zasshi
Nippon Sanka Fujinka Gakkai Zasshi (Journal of Japanese Obstetrics and Gynecology) *(Japan)*
Nippon Sanshigaku Zasshi
Nippon Sanshigaku Zasshi (Journal of the Sericultural Science of Japan) *(Japan)*
Nippon Siusan Gakkaishi
Nippon Siusan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) *(Japan)*
Nippon Univ. J. Med.
Nippon University Journal of Medicine *(Japan)*
Nippon Univ. J. Radiation Med. Biol.
Nippon University Journal of Radiation Medicine and Biology, The *(Japan)*
Nogyo Gijutsu Kenkyusho Hokoku, Chikusan
Nogyo Gijutsu Kenkyusho Hokoku (Bulletin of the National Institute of Agricultural Sciences), Chikusan (Series G) *(Japan)*
Nord. Hyg. Tidskr.
Nordisk Hygienisk Tidskrift *(Denmark)*
Nord. Med.
Nordisk Medicin *(Norway)*
Northwest Med.
Northwest Medicine *(U. S.)*
Notas Fis., Centro Brasil. Pesquisas Fis.
*Notas de Fisica, Centro Brasileiro de Pesquisas Fisicas *(Brazil)*
Notiz. Ric. Sci.
Notiziario de "La Ricerca Scientifica" *(Italy)*
Nouvelle Rev. Franc. Hematol.
Nouvelle Revue Francaise d'Hematologie *(France)*
Nowotwory
Nowotwory *(Poland)*
Nucl. Appl.
Nuclear Applications *(U. S.)*
Nucl.-Chicago Tech. Bull.
Nuclear-Chicago Technical Bulletin *(U. S.)*
Nucl. Energy
*Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*
Nucl. Eng.
*Nuclear Engineering incorporating Nuclear Power *(England)*
Nuclear Eng. (Tokyo)
Nuclear Engineering (Tokyo)
see *Genshiryoku Kogyo*
Nucleonics
*Nucleonics *(U. S.)*
Nucleus (Calcutta)
Nucleus (Calcutta) *(India)*
Nucleus (Chicago)
Nucleus (Chicago), The *(U. S.)*
Nucleus (Lahore)
Nucleus (Lahore) *(Pakistan)*
Nucleus (Paris)
*Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*
Nucl. Fusion
*Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion *(Austria)*
Nucl. Hematol.
Nuclear Hematology (included in Nuclear Energy, paged separately) *(England)*
Nucl. Inform.
*Nuclear Information *(U. S.)*
Nucl. Instr. Methods
*Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*
Nucl.-Med.
*Nuclear-Medizin *(Germany)*
Nucl. News
*Nuclear News *(U. S.)*
Nucl. Phys.
*Nuclear Physics *(Netherlands)*
Nucl. Powered Ship Res. Assoc. Japan
Nuclear Powered Ship Research Association of Japan *(Japan)*
Nucl. Safety
*Nuclear Safety (A Quarterly Technical Progress Review) *(U. S.)*
Nucl. Sci. (Taiwan)
Nuclear Science (Taiwan) *(China)*
see *Ho Tsu K'o Hsueh*

Nucl. Sci. Abstr. Japan
*Nuclear Science Abstracts of Japan *(Japan)*
Nucl. Sci. Eng.
*Nuclear Science and Engineering *(U. S.)*
Nucl. Struct. Eng.
*Nuclear Structural Engineering *(Netherlands)*
Nukl. Energija
*Nuklearna Energija *(Yugoslavia)*
Nukleonik
*Nukleonik *(Germany)*
Nukleonika
*Nukleonika† *(Poland)*
Nuntius Radiol.
*Nuntius Radiologicus *(Italy)*
Nuovi Ann. Igiene Microbiol.
Nuovi Annali d'Igiene e Microbiologia *(Italy)*
Nuovo Cimento
*Nuovo Cimento (Including all supplements) *(Italy)*
N. Y. State J. Med.
New York State Journal of Medicine *(U. S.)*
Obstet. Gynecol.
Obstetrics and Gynecology *(U. S.)*
Odontol. Revy
Odontologisk Revy *(Sweden)*
Oesterr. Akad. Wiss., Math.-Naturw. Kl., Anz.
Oesterreichische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Anzeiger *(Austria)*
Oesterr. Chemiker-Ztg.
Oesterreichische Chemiker-Zeitung *(Austria)*
Ogneupory
*Ogneupory† *(U.S.S.R.)*
Ohio J. Sci.
Ohio Journal of Science, The *(U. S.)*
Ohio State Med. J.
Ohio State Medical Journal, The *(U. S.)*
Okayama Igakkai Zasshi
*Okayama Igakkai Zasshi (Journal of the Okayama Medical Society) *(Japan)*
Okeanologiya
Okeanologiya *(U.S.S.R.)*
Oncologia
*Oncologia *(Switzerland)*
Oncol. Radiol.
Oncologia si Radiologia *(Romania)*
Onde Elec.
*Onde Electrique, L' *(France)*
Ontario Hydro Res. News
*Ontario Hydro Research News *(Canada)*
Ophthalmol. Ibero-Am.
*Ophthalmologia Ibero-Americana *(Brazil)*
Ophthalmologica
Ophthalmologica *(Switzerland)*
Opt. i Spektroskopiya
Optika i Spektroskopiya† *(U.S.S.R.)*
Opt. Spectry. (USSR) (English Transl.)
*Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*
Oral Surg., Oral Med., Oral Pathol.
Oral Surgery, Oral Medicine, Oral Pathology *(U. S.)*
Orv. Hetilap
Orvosi Hetilap *(Hungary)*
Osaka City Med. J.
*Osaka City Medical Journal *(Japan)*
Osaka Furitsu Kogyo-Shoreikan Hokoku
Osaka Furitsu Kogyo-Shoreikan Hokoku (Reports of Industrial Research Institute, Osaka Prefecture) *(Japan)*
Osaka Shiritsu Daigaku Igaku Zasshi
*Osaka Shiritsu Daigaku Igaku Zasshi (The Journal of the Osaka City Medical Center) *(Japan)*
Otolaryngology (Japan)
Otolaryngology (Japan)
see Jibi Inko-ka
Oyo Butsuri
Oyo Butsuri (Journal of Applied Physics) *(Japan)*
Pacific Med. Surg.
Pacific Medicine and Surgery *(U. S.)*
Pakistan J. Sci. Ind. Res.
*Pakistan Journal of Scientific and Industrial Research *(Pakistan)*
Pakistan Med. J.
Pakistan Medical Journal *(Pakistan)*
Panminerva Med.
Panminerva Medica *(Italy)*
Papers Meteorol. Geophys. (Tokyo)
Papers in Meteorology and Geophysics (Tokyo) *(Japan)*
Parasitology
Parasitology *(England)*
Pathol. Biol. Semaine Hop.
*Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*
Pathol. Microbiol.
Pathologia et Microbiologia *(Switzerland)*
Pathologica
*Pathologica *(Italy)*
Patol. Polska
Patologia Polska *(Poland)*
Pediat. Pratica
*Pediatria Pratica *(Brazil)*
Pediatria (Santiago, Chile)
*Pediatria (Santiago, Chile) *(Chile)*
Perspectives Biol. Med.
*Perspectives in Biology and Medicine *(U. S.)*
Pharmazie
Pharmazie, Die *(Germany)*
Pharm. Rept. (Peking)
Pharmacy Reports (Peking)
see Yao Hsueh T'ung Pao
Philips Res. Rept.
*Philips Research Reports *(Netherlands)*
Philips Tech. Rev.
*Philips Technical Review *(Netherlands)*
Phil. Mag.
*Philosophical Magazine, The *(England)*
Phil. Trans. Roy. Soc. London, Ser. A.
Philosophical Transactions of the Royal Society of London, Series A *(England)*
Phot. Korr.
Photographische Korrespondenz *(Austria)*
Photochem. Photobiol.
Photochemistry and Photobiology *(England)*
Phot. Sci. Eng.
*Photographic Science and Engineering *(U. S.)*
Phys. Can.
*Physics in Canada *(Canada)*
Phys. Chem. Solids
Physics and Chemistry of Solids, The *(U. S.)*
Phys. Fluids
*Physics of Fluids, The *(U. S.)*
Physica
*Physica *(Netherlands)*
Physics
*Physics *(U. S.)*
Physik Kondensierten Materie
*Physik der Kondensierten Materie *(Germany)*
Physiol. Plantarum
Physiologia Plantarum *(Denmark)*
Phys. Letters
*Physics Letters *(Netherlands)*
Phys. Med. Biol.
*Physics in Medicine and Biology *(England)*
Phys. Norvegica
*Physica Norvegica *(Norway)*
Phys. Rev.
*Physical Review, The *(U. S.)*
Phys. Rev. Letters
*Physical Review Letters *(U. S.)*
Phys. Status Solidi
*Physica Status Solidi *(Germany)*
Phys. Today
*Physics Today *(U. S.)*
Phyton (Buenos Aires)
Phyton (Buenos Aires) *(Argentina)*
Planetary Space Sci.
*Planetary and Space Science *(England)*
Planseeber. Pulvermet.
*Planseeberichte fuer Pulvermetallurgie Vereinigt mit Powder Metallurgy Bulletin *(Austria)*
Planta
Planta *(Germany)*
Plant Physiol.
*Plant Physiology *(U. S.)*

Plant Soil
Plant and Soil *(Netherlands)*

Plasma Phys.-Accelerators-Thermonucl. Res., J. Nucl. Energy: Pt. C
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
see *J. Nucl. Energy: Pt. C*

Plasticheskie Massy
Plasticheskie Massy† *(U.S.S.R.)*

Plastic Mater. (Tokyo)
Plastic Materials (Tokyo)
see *Purasuchikku Zairyo*

Pochvovedenie
Pochvovedenie† *(U.S.S.R.)*

Pokroky Mat. Fys. Astron.
*Pokroky Matematiky, Fysiky a Astronomie *(Czechoslovakia)*

Polar Record
Polar Record, The *(England)*

Polish Med. J.
Polish Medical Journal *(Poland)*

Polskie Arch. Med. Wewnetrznej
Polskie Archiwum Medycyny Wewnetrznej *(Poland)*

Polski Przeglad Radiol. i Med. Nuklearnej
*Polski Przeglad Radiologii i Medycyny Nuklearnej *(Poland)*

Polski Tygod. Lekar.
Polski Tygodnik Lekarski *(Poland)*

Polymer
*Polymer *(England)*

Poroshkovaya Met., Akad. Nauk Ukr. SSR
*Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*

Postepy Astron.
*Postepy Astronomii *(Poland)*

Postepy Biochem.
*Postepy Biochemii *(Poland)*

Postepy Fiz.
*Postepy Fizyki *(Poland)*

Postepy Hig. Med. Doswiadczalnej
*Postepy Higieny i Medycyny Doswiadczalnej *(Poland)*

Postepy Nauk Rolniczych
*Postepy Nauk Rolniczych *(Poland)*

Postgrad. Med.
Postgraduate Medicine *(U. S.)*

Postgrad. Med. J. (London)
Postgraduate Medical Journal (London) *(England)*

Poultry Sci.
Poultry Science *(U. S.)*

Powder Met.
*Powder Metallurgy *(England)*

Power
Power with which are consolidated Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer, and Operating Engineer *(U. S.)*

Power Reactor Technol.
*Power Reactor Technology (A Quarterly Technical Progress Review) *(U. S.)*

Poznan Towarz. Przyjaciol Nauk, Wydzial Lekar., Prace Komisji Med. Doswiadczalnej
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Medycyny Doswiadczalnej *(Poland)*

Prace Central. Inst. Ochrony Pracy
Prace Centralnego Instytutu Ochrony Pracy *(Poland)*

Prace Inst. Hutniczych
*Prace Instytutow Hutniczych *(Poland)*

Prace Inst. Maszyn Przeplywowych
Prace Instytutu Maszyn Przeplywowych *(Poland)*

Pracovni Lekar.
*Pracovni Lekarstvi *(Czechoslovakia)*

Practitioner
Practitioner, The *(England)*

Prakt. Metallog.
Praktische Metallographie *(Germany)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Presse Med.
Presse Medicale, La *(France)*

Priborostroenie
Priborostroenie *(U.S.S.R.)*

Pribory i Tekhn. Eksperim.
*Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*

Prikl. Mat. i Mekhan.
*Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*

Primena Radioaktiv. Izotopa i Jonizujucih Zracenja u Med.
*Primena Radioaktivnih Izotopa i Jonizujucih Zracenja u Medicini *(Yugoslavia)*

Priroda
*Priroda *(U.S.S.R.)*

Probl. Endokrinol. i Gormonoterap.
Problemy Endokrinologii i Gormonoterapii *(U.S.S.R.)*

Probl. Gematol. i Pereliv. Krovi
Problemy Gematologii i Perelivaniya Krovi *(U.S.S.R.)*

Proc. Am. Power Conf.
Proceedings of the American Power Conference *(U. S.)*

Proc. Am. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Ann. Meeting New Jersey Mosquito Exterm. Assoc.
Proceedings of the Annual Meeting of the New Jersey Mosquito Extermination Association *(U. S.)*

Proc. Assoc. Clin. Biochemists
Proceedings of the Association of Clinical Biochemists *(England)*

Proc. Cambridge Phil. Soc.
*Proceedings of the Cambridge Philosophical Society (England)

Proc. Chem. Soc.
*Proceedings of the Chemical Society *(England)*

Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964
Proceedings of the Conference on Remote Systems Technology, 12th [Conference], San Francisco, Nov. 30–Dec. 3, 1964 (formerly Hot Laboratories and Equipment Conference) *(U. S.)*

Proc. Congr. Intern. Federation Soc. Cosmet. Chemists, 2nd, London, 1962
Proceedings of the Congress of the International Federation of Societies of Cosmetic Chemists, 2nd Congress, London, July 2-5, 1962 (Pub. 1963) *(U. S.-England)*

[Proc.] European Regional Conf. Electron Microscopy, 3rd, Prague, 1963
[Proceedings] of the European Regional Conference on Electron Microscopy, 3rd [Conference], Prague, August 26–September 3, 1964 (Pub. 1964) *(Czechoslovakia)*

Proc. Fac. Eng. Tokai Univ.
Proceedings of the Faculty of Engineering of Tokai University *(Japan)*

Proc. Florida Mango Forum
Proceedings of the Florida Mango Forum *(U. S.)*

Proc. Geol. Assoc. Can.
*Proceedings of the Geological Association of Canada *(Canada)*

Proc. IEEE (Inst. Elec. Electron. Engrs.)
*Proceedings of the IEEE (Institute of Electrical and Electronics Engineers) (formerly Proceedings of the Institute of Radio Engineers) *(U. S.)*

Proc. Indiana Acad. Sci.
*Proceedings of the Indiana Academy of Science *(U. S.)*

Proc. Indian Acad. Sci., Sect. A
*Proceedings of the Indian Academy of Sciences, Section A *(India)*

Proc. Inst. Elec. Engrs. (London)
*Proceedings of the Institution of Electrical Engineers, The (London) *(England)*

Proc. Inst. Med. Chicago
Proceedings of the Institute of Medicine of Chicago *(U. S.)*

Proc. Intern. Congr. Human Genet., 2nd, Rome, 1961
Proceedings of the International Congress of Human Genetics, 2nd Congress, Rome, Sept. 6-12, 1961 (Pub. 1963) *(Italy)*

Proc. Iowa Acad. Sci.
*Proceedings of the Iowa Academy of Science *(U. S.)*

Proc. Japan Acad.
Proceedings of the Japan Academy *(Japan)*

Proc. Leeds Phil. Lit. Soc., Sci. Sect.
*Proceedings of the Leeds Philosophical and Literary Society, Scientific Section *(England)*

Proc. Natl. Acad. Sci. U. S.
*Proceedings of the National Academy of Sciences of the United States of America *(U. S.)*

Proc. Natl. Inst. Sci. India. Pt. A
*Proceedings of the National Institute of Sciences of India. Part A *(India)*

Proc. Natl. Inst. Sci. India, Pt. B
*Proceedings of the National Institute of Sciences of India, Part B *(India)*

Proc. Nutr. Soc. (Engl.-Scot.)
Proceedings of the Nutrition Society (England and Scotland) *(England)*
Proc. Penn. Acad. Sci.
Proceedings of the Pennsylvania Academy of Science *(U. S.)*
Proc. Phys. Seminar Trondheim
Proceedings of the Physics Seminar in Trondheim
see *Ark. Fys. Seminar Trondheim*
Proc. Phys. Soc. (London)
*Proceedings of the Physical Society (London), The *(England)*
Proc. Phys. Soc. Japan
Proceedings of the Physical Society of Japan
see *Nippon Butsuri Gakkaisi*
Proc. Res. Inst. Nucl. Med. Biol.
*Proceedings of Research Institute for Nuclear Medicine and Biology *(Japan)*
Proc. Roy. Irish Acad., Sect. A
*Proceedings of the Royal Irish Academy, Section A *(Ireland)*
Proc. Roy. Soc. Edinburgh, A
*Proceedings of the Royal Society of Edinburgh, Section A *(Scotland)*
Proc. Roy. Soc. (London), Ser. A
*Proceedings of the Royal Society (London), Series A *(England)*
Proc. Roy. Soc. (London), Ser. B
*Proceedings of the Royal Society (London), Series B *(England)*
Proc. Soc. Exptl. Biol. Med.
*Proceedings of the Society for Experimental Biology and Medicine *(U. S.)*
Proc. Vibration Probl.
*Proceedings of Vibration Problems *(Poland)*
Proc. Western Pharmacol. Soc.
Proceedings of the Western Pharmacology Society *(U. S.)*
Proc. Zool. Soc. London
Proceedings of the Zoological Society of London *(England)*
Progr. Biophys. Mol. Biol.
Progress in Biophysics and Molecular Biology (formerly Progress in Biophysics and Biophysical Chemistry) *(U. S.)*
Progr. Cardiovascular Diseases
Progress in Cardiovascular Diseases *(U. S.)*
Progr. Cryog.
Progress in Cryogenics *(England)*
Progr. Hematol.
Progress in Hematology *(U. S.)*
Progr. Powder Met.
Progress in Powder Metallurgy *(U. S.)*
Progr. Med.
Progresso Medico, Il *(Italy)*
Progr. Nucl. Phys.
*Progress in Nuclear Physics *(U. S.)*
Progr. Radiation Therapy
Progress in Radiation Therapy *(U. S.)*
Progr. Theoret. Phys. (Kyoto)
*Progress of Theoretical Physics (Kyoto) *(Japan)*
Progr. Theoret. Phys. (Kyoto), Suppl.
*Progress of Theoretical Physics (Kyoto), Supplement *(Japan)*
Protides Biol. Fluids, Proc. Colloq.
*Protides of the Biological Fluids, Proceedings of the Colloquium *(Belgium)*
Protoplasma
Protoplasma *(Austria)*
Prumysl Potravin
Prumysl Potravin *(Czechoslovakia)*
Przeglad Dermatol.
Przeglad Dermatologiczny *(Poland)*
Przeglad Elektron.
*Przeglad Elektroniki *(Poland)*
Przeglad Elektrotech.
Przeglad Elektrotechniczny *(Poland)*
Przeglad Geofiz.
*Przeglad Geofizyczny *(Poland)*
Przeglad Geol.
*Przeglad Geologiczny *(Poland)*
Przeglad Odlewnictwa
*Przeglad Odlewnictwa *(Poland)*
Przemysl Chem.
*Przemysl Chemiczny *(Poland)*
Psychol. Bull.
Psychological Bulletin *(U. S.)*
Psychol. Rept.
Psychological Reports *(U. S.)*

Publ. Astron. Soc. Japan
Publications of the Astronomical Society of Japan *(Japan)*
Public Health Eng. Abstr.
*Public Health Engineering Abstracts *(U. S.)*
Public Health Rept. (U. S.)
*Public Health Reports *(U. S.)*
Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres
*Publicaciones del Laboratorio de Fisica Cosmica, Universidad Mayor de San Andres *(Bolivia)*
Purasuchikku Zairyo
Purasuchikku Zairyo (Plastic Materials) *(Japan)*
Pure Appl. Chem.
*Pure and Applied Chemistry (The Official Journal of the International Union of Pure and Applied Chemistry) *(U. S.)*
Pure Appl. Geophys.
*Pure and Applied Geophysics (formerly Geofizika Pura e Aplicata) *(Switzerland)*
Quaderni Clin. Obstet. Ginecol.
Quaderni di Clinica Obstetrica e Ginecologica *(Italy)*
Quaderni Radiol.
Quaderni di Radiologia *(Italy)*
Quart. Appl. Math.
*Quarterly of Applied Mathematics *(U. S.)*
Quart. J. Roy. Astron. Soc.
*Quarterly Journal of the Royal Astronomical Society, The *(England)*
Quart. Rev. (London)
*Quarterly Reviews (London) *(England)*
Queensland J. Agr. Sci.
*Queensland Journal of Agricultural Science, The *(Australia)*
Radiation Botany
*Radiation Botany *(England)*
Radiation Res.
*Radiation Research *(U. S.)*
Radiation Res. Polymers
Radiation Research on Polymers
see *Hoshasen Kobunshi*
Radiazioni Alta Energia
Radiazioni di Alta Energia *(Italy)*
Radioact. Sea
*Radioactivity in the Sea *(Austria)*
Radioaktivni Izotopi i Zracenja
Radioaktivni Izotopi i Zracenja *(Yugoslavia)*
Radiobiol. Latina
*Radiobiologica Latina *(Italy)*
Radiobiologiya
*Radiobiologiya† *(U.S.S.R.)*
Radiobiol. Radioterap. Fis. Med.
*Radiobiologia, Radioterapia e Fisica Medica (formerly Radioterapia, Radiobiologia e Fisica Medica) *(Italy)*
Radiobiol. Radiotherap.
*Radiobiologia–Radiotherapie *(Germany)*
Radiocarbon
*Radiocarbon *(U. S.)*
Radiochim. Acta
*Radiochimica Acta *(Germany)*
Radio Electron. Engr.
Radio and Electronic Engineer, The *(England)*
Radiography
Radiography *(England)*
Radioisotopes (Tokyo)
*Radioisotopes (Tokyo) *(Japan)*
Radiokhimiya
*Radiokhimiya† *(U.S.S.R.)*
Radiol. Austriaca
Radiologia Austriaca *(Austria)*
Radiol. Clin.
*Radiologia Clinica *(Switzerland)*
Radiol. Diagn.
*Radiologia Diagnostica *(Germany)*
Radiol. Health Data
*Radiological Health Data *(U. S.)*
Radiol. Med.
*Radiologia Medica, La *(Italy)*
Radiologe
Radiologe *(Germany)*
Radiology
*Radiology *(U. S.)*
Radiol. Technol.
Radiologic Technology (formerly X-Ray Technician) *(U. S.)*

Radiotekhn. i Elektron.
*Radiotekhnika i Elektronika' *(U.S.S.R.)*
Rass. Chim.
Rassegna Chimica *(Italy)*
Rass. Clin.-Sci. Ist. Biochim. Ital.
Rassegna Clinico-Scientifica dell'Istituto Biochimico Italiano *(Italy)*
Russ. Med. Ind.
Rassegna di Medicina Industriale *(Italy)*
Raumfahrtforschung
*Raumfahrtforschung (formerly Raketentechnik und Raumfahrtforschung) *(Germany)*
R C A Rev.
*R C A Review *(U. S.)*
Reactor Fuel Process.
*Reactor Fuel Processing (A Quarterly Technical Progress Review) *(U. S.)*
Reactor Mater.
*Reactor Materials (A Quarterly Technical Progress Review) *(U. S.)*
Reactor Sci. Technol., J. Nucl. Energy: Pt. A & B
Reactor Science and Technology, Journal of Nuclear Energy: Parts A & B
see ***J. Nucl. Energy: Pt. A & B***
Rec. Trav. Chim.
*Recueil des Travaux Chimiques des Pays-Bas *(Netherlands)*
Rend. Ist. Super. Sanita
Rendiconti Istituto Superiore di Sanita *(Italy)*
Rept. Army Res. Testing Lab.
*Report of the Army Research and Testing Laboratory *(Korea)*
Rept. Ferment. Res. Inst.
Report of the Fermentation Research Institute
see ***Kogyo Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku***
Rept. Govt. Chem. Ind. Res. Inst., Tokyo
Reports of the Government Chemical Industrial Research Institute, Tokyo
see ***Tokyo Kogyo Shikensho Hokoku***
Rept. Govt. Ind. Res. Inst., Nagoya
Reports of the Government Industrial Research Institute, Nagoya
see ***Nagoya Kogyo Gijutsu Shikensho Hokoku***
Rept. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Institute, Osaka Prefecture
see ***Osaka Furitsu Kogyo-Shoreikan Hokoku***
Rept. Inst. Phys. Chem. Res. (Tokyo)
Reports of the Institute of Physical and Chemical Research (Tokyo)
see ***Rika Gaku Kenkyusho Hokoku***
Rept. Ionosphere Space Res. Japan
Report of Ionosphere and Space Research in Japan *(Japan)*
Rept. Kihara Inst. Biol. Res.
Reports of the Kihara Inst. for Biological Research
see ***Seiken Jiho***
Rept. Liberal Arts Sci. Faculty Shizuoka Univ., Nat. Sci.
Reports of Liberal Arts and Science Faculty Shizuoka University, Natural Science *(Japan)*
Rept. Progr. Appl. Chem.
Reports on the Progress of Applied Chemistry *(England)*
Rept. Progr. Phys.
Reports on Progress in Physics *(England)*
Rept. Res. Lab. Surface Sci., Fac. Sci., Okayama Univ.
Reports of the Research Laboratory for Surface Science, Faculty of Science, Okayama University *(Japan)*
RES; J. Reticuloendothelial Soc.
RES; Journal of the Reticuloendothelial Society
see ***J. Reticuloendothelial Soc.***
Res. Reactor J.
*Research Reactor Journal *(U. S.)*
Res. Rev. (Office Aerospace Res.)
*Research Review (Office of Aerospace Research) *(U. S.)*
Reumatismo
*Reumatismo *(Italy)*
Rev. Aluminium
Revue de l'Aluminium *(France)*
Rev. Arg. Alergia
*Revista Argentina de Alergia *(Argentina)*
Rev. Arg. Anestesiol.
*Revista Argentina de Anestesilogia *(Argentina)*
Rev. Arg. Tuberc. Enfermedades Pulmonares
*Revista Argentina de Tuberculosis y Enfermedades Pulmonares *(Argentina)*
Rev. Arg. Urol.
Revista Argentina de Urologia *(Argentina)*
Rev. Asoc. Med. Rio Grande do Sul
*Revista da Asociacao Medica do Rio Grande do Sul *(Brazil)*
Rev. Belge Pathol. Med. Exptl.
*Revue Belge de Pathologie et de Medecine Experimentale *(Belgium)*
Rev. Brasil. Cirurg.
Revista Brasileira de Cirurgia *(Brazil)*
Rev. Brasil. Gastroenterol.
*Revista Brasileira de Gastroenterologia *(Brazil)*
Rev. Can. Biol.
*Revue Canadienne de Biologie *(Canada)*
Rev. Chilena Pediat.
*Revista Chilena de Pediatria *(Chile)*
Rev. Chim. (Bucharest)
Revista de Chimie (Bucharest) *(Romania)*
Rev. Chim., Acad. Rep. Populaire Roumaine
Revue de Chimie, Academie de la Republique Populaire Roumaine *(Romania)*
Rev. Col. Med. Guatemala
*Revista del Colegio Medico de Guatemala *(Guatemala)*
Rev. Cubana Cardiol.
*Revista Cubana de Cardiologia *(Cuba)*
Rev. Elec. Commun. Lab. (Tokyo)
Review of the Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation (Tokyo) *(Japan)*
Rev. Electrotech. Energet., Acad. Rep. Populaire Roumaine
*Revue d'Electrotechnique et d'Energetique, Academie de la Republique Populaire Roumaine *(Romania)*
Rev. Espan. Fisiol.
*Revista Espanola de Fisiologia *(Spain)*
Rev. Espan. Oto-neuro-oftalmol. Neurocir.
*Revista Espanola de Oto-neuro-oftalmologia y Neurocirugia *(Spain)*
Rev. Espan. Reumat. Enfermedades Osteoarticulares
*Revista Espanola de Reumatismo y Enfermedades Osteoarticulares *(Spain)*
Rev. Espan. Tuberc.
*Revista Espanola de Tuberculosis y Archivos Nacionales de Enfermedades del Torax *(Spain)*
Rev. Franc. Etudes Clin. Biol.
Revue Francaise d'Etudes Cliniques et Biologiques *(France)*
Rev. Franc. Gynecol. Obstet.
Revue Francaise de Gynecologie et d'Obstetrique *(France)*
Rev. Gen. Mecan.
Revue Generale de Mecanique *(France)*
Rev. Geophys.
*Reviews of Geophysics *(U. S.)*
Rev. Ginecol. Obstet. (Rio de Janeiro)
*Revista de Ginecologia e d'Obstetricia (Rio de Janeiro) *(Brazil)*
Rev. Goiana Med.
*Revista Goiana de Medicina *(Brazil)*
Rev. Hautes Temp. Refractaires
*Revue des Hautes Temperatures et des Refractaires *(France)*
Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo
*Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*
Rev. Hosp. Nino (Lima)
*Revista del Hospital del Nino (Lima) *(Peru)*
Rev. Hosp. San Juan de Dios (Bogota)
*Revista del Hospital de San Juan de Dios (Bogota) *(Colombia)*
Rev. Hyg. Med. Sociale
Revue d'Hygiene et de Medecine Sociale *(France)*
Rev. Iberica Endocrinol.
*Revista iberica de Endocrinologia *(Spain)*
Rev. Immunol.
*Revue d'Immunologie et de Therapie Antimicrobienne *(France)*
Rev. Inst. Ing. Elec.
*Revista del Instituto de Ingenieria Electrica *(Argentina)*
Rev. Inst. Med. Trop. Sao Paulo
*Revista do Instituto de Medicina Tropical de Sao Paulo *(Brazil)*
Rev. Invest. Clin. Organo Hosp. Enfermedades Nutr. Mex.
*Revista de Investigacion Clinica, Organo del Hospital de Enfermedades de la Nutricion, Mexico *(Mexico)*
Rev. Latinoam. Anat. Patol.
*Revista Latinoamericana de Anatomia Patologica *(Venezuela)*

Rev. Latino-Am. Cir. Plastica
*Revista Latinoamericana de Cirugia Plastica *(Mexico)*
Rev. Latinoam. Microbiol.
*Revista Latinoamericana de Microbiologia *(Mexico)*
Rev. Leprol. (Fontilles)
*Revista de Leprologia (Fontilles) *(Spain)*
Rev. Lyon. Med.
Revue Lyonnaise de Medecine, La *(France)*
Rev. M.B.L.E.
*Revue de Manufacture Belge de Lampes et de Materiel *(Belgium)*
Rev. Med. Aeron. (Paris)
Revue de Medecine Aeronautique (Paris) *(France)*
Rev. Med. Aeron. (Rio de Janeiro)
*Revista Medica da Aeronautica (Rio de Janeiro) *(Brazil)*
Rev. Med. Cordoba
*Revista Medica de Cordoba *(Argentina)*
Rev. Med. Hosp. Colonia (Mex.)
*Revista Medica del Hospital Colonia *(Mexico)*
Rev. Med. Hosp. Espan. (Mex.)
*Revista Medica del Hospital Espanol *(Mexico)*
Rev. Med. Hosp. Obrero (Lima)
*Revista Medica del Hospital Obrero (Lima) *(Peru)*
Rev. Med. Liege
Revue Medicale de Liege *(Belgium)*
Rev. Med. Moyen-Orient
Revue Medicale du Moyen-Orient *(France)*
Rev. Med. Rio Grande do Sul
*Revista de Medicina do Rio Grande do Sul *(Brazil)*
Rev. Med. Suisse Romande
Revue Medicale de la Suisse Romande *(Switzerland)*
Rev. Med. Valparaiso
*Revista Medica de Valparaiso *(Chile)*
Rev. Met. (Paris)
*Revue de Metallurgie (Paris) *(France)*
Rev. Metal Lit.
*Review of Metal Literature *(U. S.)*
Rev. Mex. Cienc. Med. Biol.
*Revista Mexicana de Ciencias Medicas y Biologicas *(Mexico)*
Rev. Mex. Cir. Ginecol. Cancer
*Revista Mexicana de Cirugia, Ginecologia y Cancer *(Mexico)*
Rev. Mex. Fis.
*Revista Mexicana de Fisica *(Mexico)*
Rev. Mex. Tuberc. Aparato Respirat.
*Revista Mexicana de Tuberculosis y Aparato Respiratorio *(Mexico)*
Rev. Mod. Phys.
*Reviews of Modern Physics *(U. S.)*
Rev. Neurol. Buenos Aires
*Revista Neurologica de Buenos Aires *(Argentina)*
Rev. Obstet. Ginecol. (Caracas)
*Revista de Obstetricia y Ginecologia (Caracas) *(Venezuela)*
Rev. Ortoped. Traumatol. Latinoam.
*Revista de Ortopedia y Traumatologia Latinoamericana *(Argentina)*
Rev. Otorrinolaringol. (Santiago, Chile)
*Revista de Otorrinolaringologia (Santiago, Chile) *(Chile)*
Rev. Paulista Med.
Revista Paulista de Medicina *(Brazil)*
Rev. Phys., Acad. Rep. Populaire Roumaine
*Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*
Rev. Phys. Chem. Japan
Review of Physical Chemistry of Japan, The *(Japan)*
Rev. Port. Quim. (Lisbon)
*Revista Portuguesa de Quimica (Lisbon) *(Portugal)*
Rev. Praticien
Revue du Praticien *(France)*
Rev. Psiquiat. (Santiago, Chile)
*Revista de Psiquiatria (Santiago, Chile) *(Chile)*
Rev. Psiquiat. Peruana
*Revista Psiquiatrica Peruana *(Peru)*
Rev. Pure Appl. Chem.
*Reviews of Pure and Applied Chemistry *(Australia)*
Rev. Rhumat.
*Revue du Rhumatisme et des Maladies Osteo-Articulaires *(France)*

Rev. Roumaine Chim.
*Revue Roumaine de Chimie (continuation of Revue de Chimie, Academie de la Republique Populaire Roumaine) *(Romania)*
Rev. Roumaine Phys.
Revue Roumaine de Physique *(Romania)*
Rev. Sanit. Mil.
Revista Sanitara Militara *(Romania)*
Rev. Sci. Instr.
*Review of Scientific Instruments, The *(U. S.)*
Rev. Sci. Med., Acad. Rep. Populaire Roumaine
Revue des Sciences Medicales, Academia de la Republique Populaire Roumaine *(Romania)*
Rev. Soc. Med.-Quir. Zulia
*Revista de la Sociedad Medico-Quirurgica del Zulia *(Venezuela)*
Rev. Trav. Inst. Peches Maritimes
Revue des Travaux, Institut des Peches Maritimes *(France)*
Rev. Tuberc. (Paris)
Revue de la Tuberculose (Paris) *(France)*
Rev. Union Mat. Arg. Asoc. Fis. Arg.
*Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*
Rev. Univ. Ind. Santander
*Revista de la Universidad Industrial de Santander *(Colombia)*
Rev. Urol. (Caracas)
*Revista de Urologia (Caracas) *(Venezuela)*
Rev. Urol. (Mex.)
*Revista de Urologia *(Mexico)*
Rheumatism
*Rheumatism *(England)*
Ric. Sci. Rend., Sez. A
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione A, Abiologica *(Italy)*
Ric. Sci. Rend., Sez. B
*Ricerca Scientifica, La. Parte 2: Rendiconti, Sezione B, Biologica *(Italy)*
Riforma Med.
Riforma Medica, La *(Italy)*
Rika Gaku Kenkyusho Hokoku
*Rika Gaku Kenkyusho Hokoku (Reports of the Institute of Physical and Chemical Research) *(Japan)*
Rinsho Hoshasen
Rinsho Hoshasen (Clinical Radiology) *(Japan)*
Rinsho Ketsueki
Rinsho Ketsueki (The Japanese Journal of Clinical Hematology) *(Japan)*
Riv. Anat. Patol. Oncol.
Rivista di Anatomia Patologica e di Oncologia *(Italy)*
Riv. Biol.
Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*
Riv. Clin. Pediat.
*Rivista di Clinica Pediatrica *(Italy)*
Riv. Infortuni Mal. Profess.
Rivista degli Infortuni e delle Malattie Professionali *(Italy)*
Riv. Ing. Nucl.
*Rivista di Ingegneria Nucleare *(Italy)*
Riv. Ist. Sieroterap. Ital.
*Rivista dell'Istituto Sieroterapico Italiano *(Italy)*
Riv. Ital. Igiene
Rivista Italiana d'Igiene *(Italy)*
Riv. Ital. Saldatura
Rivista Italiana della Saldatura *(Italy)*
Riv. Med. Aeron. Spaziale
Rivista di Medicina Aeronautica e Spaziale *(Italy)*
Rivoluzione Ind.
*Rivoluzione Industriale *(Italy)*
Riv. Ostet. Ginecol.
Rivista di Ostetricia e Ginecologia *(Italy)*
Riv. Ostet. Ginecol. Prat.
Rivista d'Ostetricia e Ginecologia Pratica *(Italy)*
Riv. Patol. Clin.
Rivista di Patologia e Clinica *(Italy)*
Riv. Storia Med.
Rivista di Storia della Medicina *(Italy)*
Roczniki Chem.
*Roczniki Chemii *(Poland)*
Roczniki Panstwowego Zakladu Hig.
*Roczniki Panstwowego Zakladu Higieny *(Poland)*
Roentgen-Lab. Praxis
Roentgen- und Laboratoriums Praxis *(Germany)*

Rozhledy Tuberk.
Rozhledy v Tuberkulose a Nemocech Plicnich *(Czechoslovakia)*

Rozprawy Elektrotech.
*Rozprawy Elektrotechniczne *(Poland)*

Rudy Metale Niezelazne
*Rudy i Metale Niezelazne *(Poland)*

Rumanian Med. Rev.
*Rumanian Medical Review *(Romania)*

S. African J. Radiol.
*South African Journal of Radiology *(S. Africa)*

S. African Med. J.
South African Medical Journal *(S. Africa)*

Saiko To Hoan
Saiko To Hoan (Mining and Safety) *(Japan)*

Sanfujinka No Sekai
Sanfujinka No Sekai (The World of Obstetrics and Gynecology) *(Japan)*

Sanfujinka no Shimpo
Sanfujinka no Shimpo (Advances in Obstetrics and Gynaecology) *(Japan)*

Santo Tomas J. Med.
*Santo Tomas Journal of Medicine *(Philippines)*

Saopstenja Inst. Vodoprivredu "Jaroslav Cerni"
Saopstenja Instituta za Vodoprivredu "Jaroslav Cerni" *(Yugoslavia)*

Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR
*Sbornik Nauchnykh Trudov Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR (formerly Sbornik Nauchnykh Rabot Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR) *(Ukrainian S.S.R.)*

Sb. Rabot po Nekotorym Vopr. Dozimetr. i Radiometr. Ionizir. Izluchenii
Sbornik Rabot po Nekotorym Voprosma Dozimetrii i Radiometrii Ioniziruyushchika Izluchenii *(U.S.S.R.)*

Sb. Statei Obshch. Khim., Akad. Nauk SSSR
Sbornik Statei po Obshchei Khimii, Akademiya Nauk SSSR *(U.S.S.R.)*

Sb., Teoriya i Prakt. Stomatologii
Sbornik, Teoriya i Praktika Stomatologii *(U.S.S.R.)*

Sb. Tr. Leningr. Mekhan. Inst.
Sbornik Trudov Leningradskogo Mekhanicheskogo Instituta *(U.S.S.R.)*

Sb. Tr. Sverdlovsk. Gos. Med. Inst.
Sbornik Trudov Sverdlovskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*

Sb. Tr. Tsentr. Nauchn.-Issled. Inst. Chernoi Met.
Sbornik Trudov Tsentral'nogo Nauchno-Issledovatel'skogo Instituta Chernoi Metallurgii *(U.S.S.R.)*

Sb. Tr., Vses. Nauchn.-Issled. Inst. Tverd. Splavov
Sbornik Trudov, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Tverdykh Splavov *(U.S.S.R.)*

Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove
*Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest.
Scandinavian Journal of Clinical & Laboratory Investigation *(Denmark)*

Scand. J. Haematol.
*Scandinavian Journal of Haematology *(Denmark)*

Schriftenreihe Bundesmin. Atomkernenergie Wasserwirtsch. (Munich)
*Schriftenreihe des Bundesministers fuer Atomkernenergie und Wasserwirtschaft (Munich) *(Germany)*

Schriftenreihe Bundesmin. Wiss. Forsch., Strahlenschutz (Munich)
*Schriftenreihe des Bundesministers fuer Wissenschaftliche Forschung, Strahlenschutz (Munich) *(Germany)*

Schweiz. Arch. Angew. Wiss. Tech.
*Schweizer Archiv fuer Angewandte Wissenschaft und Technik *(Switzerland)*

Schweiz. Bl. Arbeitssicherheit
Schweizerische Blaetter fuer Arbeitssicherheit *(Switzerland)*

Schweiz. Med. Wochschr.
Schweizerische Medizinische Wochenschrift *(Switzerland)*

Schweiz. Tech. Z.
Schweizerische Technische Zeitschrift *(Switzerland)*

Sci. Am.
*Scientific American *(U. S.)*

Sci. Basis Med., Ann. Rev.
Scientific Basis of Medicine, Annual Reviews (formerly Lectures on the Scientific Basis of Medicine) *(England)*

Sci. Cult. (Calcutta)
Science and Culture (Calcutta) *(India)*

Science
*Science *(U. S.)*

Sci. Eng. Rev. Doshisha Univ.
Science and Engineering Review of the Doshisha University *(Japan)*

Scientia (Milan)
Scientia (Milan) *(Italy)*

Scientia (Peking)
Scientia (Peking)
see *K'o Hsueh T'ung Pao*

Scientia (Valparaiso, Chile)
*Scientia (Valparaiso, Chile) *(Chile)*

Scientiae
*Scientiae *(South Africa)*

Scientist Citizen
Scientist and Citizen (formerly Nuclear Information) *(U. S.)*

Sci. Papers Coll. Gen. Educ., Univ. Tokyo
*Scientific Papers of the College of General Education, University of Tokyo *(Japan)*

Sci. Papers Inst. Phys. Chem. Res. (Tokyo)
*Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*

Sci. Pharm.
Scientia Pharmaceutica *(Austria)*

Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Progr. (London)
*Science Progress (London) *(England)*

Sci. Progr.-Nature
*Science Progres--La Nature *(France)*

Sci. Publ. Fuji Photo Film Co., Ltd.
Scientific Publications of the Fuji Photo Film Co., Ltd. *(Japan)*

Sci. Rept. Fac. Agr. Ibaraki Univ.
Scientific Reports of the Faculty of Agriculture, Ibaraki University
see *Ibaraki Daigaku Nogakubu Gakujitsu Hokoku*

Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ.
*Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. A
*Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*

Sci. Rept. Res. Inst., Tokoku Univ., Ser. B
Science Reports of the Research Institutes, The, Tohoku University, Series B *(Japan)*

Sci. Rept. Saitama Univ., Ser. A
*Science Reports of Saitama University, The, Series A *(Japan)*

Sci. Rept. Tohoku Univ., Fifth Ser.
Science Reports of the Tohoku University, Fifth Series *(Japan)*

Sci. Sinica (Peking)
*Scientia Sinica (Peking) (Chung Kuo K'o Hsueh) *(China)*

Scripta Med. Fac. Med. Univ. Brun. Olomuc.
Scripta Medica Facultatum Medicinae Universitatum Brunensis et Olomucencis *(Czechoslovakia)*

Seikagaku
Seikagaku (Biochemistry) *(Japan)*

Seiken Jiho
Seiken Jiho (Reports of the Kihara Inst. for Biological Research) *(Japan)*

Seisan-Kenkyu
Seisan-Kenkyu (Industrial Production Research) *(Japan)*

Sekiyu Gijutsu Kyokaishi
Sekiyu Gijutsu Kyokaishi (Journal of the Japanese Association of Petroleum Technologists) *(Japan)*

Semaine Med. Profess. Med.-Soc.
Semaine Medicale Professionnelle et Medico-Sociale *(France)*

Setchaku
Setchaku (Adhesion and Adhesives) *(Japan)*

Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao
Sheng Wu Hua Hsueh Yu Shing Wu Wu Li Hsueh Pao (Acta Biochimica et Biophysica Sinica) *(China)*

Shih Yen Sheng Wu Hsueh Pao
Shih Yen Sheng Wu Hsueh Pao (Acta Biologiae Experimentalis Sinica) *(China)*

Shikoku Acta Med.
Shikoku Acta Medica
see *Shikoku Igaku Zasshi*

Shikoku Igaku Zasshi
*Shikoku Igaku Zasshi (Shikoku Acta Medica) *(Japan)*

Shinku Kagaku
Shinku Kagaku (Vacuum Chemistry) *(Japan)*

Shitsuryo Bunseki
Shitsuryo Bunseki (Mass Spectroscopy (Tokyo)) *(Japan)*

Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see *Showa Densen Denran Rebyu*

SIAM (Soc. Ind. Appl. Math.) Rev.
SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*

Sibirsk. Mat. Zh.
Sibirskii Matematicheskii Zhurnal *(U.S.S.R.)*

Sitzber. Deut. Akad. Wiss. Berlin, Kl. Bergbau, Huettenwesen Montangeol.
Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fuer Bergbau, Huettenwesen und Montangeologie *(Germany)*

Sitzber. Ges. Befoerder. Ges. Naturw. Marburg
*Sitzungsberichte der Gesellschaft zur Befoerderung der Gesamten Naturwissenschaften zu Marburg *(Germany)*

Skin
Skin *(U. S.)*

Sklar Keram.
Sklar a Keramik *(Czechoslovakia)*

Soc. Sci. Fennica, Commentationes Phys.-Math.
*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*

Sogo Rinsho
Sogo Rinsho (Clinics All-round (Osaka)) *(Japan)*

Sogo Shikensho Nempo
Sogo Shikensho Nempo (Annual Report of the Engineering Research Institute) *(Japan)*

Soil Sci.
*Soil Science *(U. S.)*

Soil Sci. Soc. Am., Proc.
*Soil Science Society of America, Proceedings *(U. S.)*

Solid State Commun.
*Solid State Communications *(U. S.)*

Soobshch. Akad. Nauk Gruz. SSR
Soobshcheniya Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Soryushiron Kenkyu
Soryushiron Kenkyu (Study of Elementary Particles) *(Japan)*

Southern Med. J.
Southern Medical Journal *(U. S.)*

Soviet Astron. AJ (English Transl.)
*Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*

Soviet Phys.–Cryst. (English Transl.)
*Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*

Soviet Phys.-Solid State (English Transl.)
*Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*

Soviet Powder Met. Metal Ceram. (English Transl.)
Soviet Powder Metallurgy and Metal Ceramics (English Translation of Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR) *(U. S.)*

Sov. Med.
Sovetskaya Meditsina *(U.S.S.R.)*

Space/Aeron.
Space/Aeronautics *(U. S.)*

Space Sci. Rev.
*Space Science Reviews *(Netherlands)*

Spectrochim. Acta
*Spectrochimica Acta *(England)*

Srpski Arhiv Celokupno Lekar.
Srpski Arhiv za Celokupno Lekarstvo *(Yugoslavia)*

Stahl Eisen
Stahl und Eisen *(Germany)*

Staub
*Staub *(Germany)*

Stomatologiya
Stomatologiya *(U.S.S.R.)*

Strahlentherapie
*Strahlentherapie *(Germany)*

Strahlentherapie, Sonderbaende
*Strahlentherapie, Sonderbaende *(Germany)*

Studia Math.
*Studia Mathematica *(Poland)*

Studia Univ. Babes-Bolyai, Ser. Chem.
*Studia Universitatis Babes-Bolyai, Series Chemia *(Romania)*

Studia Univ. Babes-Bolyai, Ser. Math.-Phys.
*Studia Universitatis Babes-Bolyai, Series Mathematica-Physica *(Romania)*

Studi Sassaresi, Sezione I
Studi Sassaresi, Sezione I *(Italy)*

Study Elem. Particles (Japan)
Study of Elementary Particles (Japan)
see *Soryushiron Kenkyu*

Sulzer Tech. Rev. (Switz.)
*Sulzer Technical Review *(Switzerland)*

Sumitomo Keikinzoku Giho
Sumitomo Keikinzoku Giho (Sumitomo Light Metals Technical Reports) *(Japan)*

Sumitomo Light Metals Tech. Rept.
Sumitomo Light Metals Technical Reports
see *Sumitomo Keikinzoku Giho*

Surface Sci.
Surface Science *(Netherlands)*

Surg. Clin. North Am.
Surgical Clinics of North America, The *(U. S.)*

Surg. Forum
Surgical Forum *(U. S.)*

Surg., Gynecol. Obstet.
Surgery, Gynecology and Obstetrics with International Abstracts of Surgery *(U. S.)*

Suvremenna Med.
Suvremenna Meditsina *(Bulgaria)*

Svarochn. Proizv.
Svarochnoe Proizvodstvo† *(U.S.S.R.)*

Svensk Kem. Tidskr.
Svensk Kemisk Tidskrift *(Sweden)*

Tabacco
Tabacco, Il *(Italy)*

Taiki Hoshano Kansoku Seiseki
*Taiki Hoshano Kansoku Seiseki (Bulletin of the Atmospheric Radioactivity) *(Japan)*

T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China)*

Talanta
*Talanta *(England)*

Tech. Dig. (Prague)
Technical Digest, A Monthly Review of Technology and Science in Socialist Countries (Prague) *(Czechoslovakia)*

Tech. Hosp. (Paris)
Techniques Hospitalieres, Medico-Sociales et Sanitaires (Paris) *(France)*

Tech. Mitt. Krupp. Forschungsber.
*Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*

Tech. Mod.
Technique Moderne; Revue Universelle des Sciences Appliquees a l'Industrie *(France)*

Technol. Rept. Osaka Univ.
Technology Reports of the Osaka University *(Japan)*

Tech. Rept. Eng. Res. Inst., Kyoto Univ.
*Technical Reports of the Engineering Research Institute, Kyoto University *(Japan)*

Tech. Ueberwach.
*Technische Ueberwachung *(Germany)*

Tech. Zpravodaj
Technicky Zpravodaj *(Czechoslovakia)*

Tehnika (Belgrade)
Tehnika (Belgrade) *(Yugoslavia)*

Tehn. ja Tootmine
Tehnika ja Tootmine *(Estonian S.S.R.)*

Tekhn. Molodezhi
Tekhnika Molodezhi *(U.S.S.R.)*

Telefunken Ztg.
*Telefunken Zeitung *(Germany)*

Tellus
*Tellus. A Quarterly Journal of Geophysics *(Sweden)*
Teor. i Eksperim. Khim.
*Teoreticheskaya i Eksperimentalnaya Khimiya *(Ukrainian S.S.R.)*
Teploenergetika
*Teploenergetika *(U.S.S.R.)*
Teplofiz. Vysokikh Temp.
Teplofizika Vysokikh Temperatur† *(U.S.S.R.)*
Teplo i Massoperenos, Pervoe Vses. Soveshch., Minsk, 1961
Teplo i Massoperenos, Pervoe Vsesoyuznoe Soveshchanie, Minsk, June 5–9, 1961, Vol. 1 (Pub. 1962) *(Belorussian S.S.R.)*
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Termotecnica, La (Milan) *(Italy)*
Tetrahedron
*Tetrahedron *(Northern Ireland)*
Tetrahedron Letters
Tetrahedron Letters *(Northern Ireland)*
Texas J. Sci.
Texas Journal of Science, The *(U. S.)*
Texas Rept. Biol. Med.
*Texas Reports on Biology and Medicine *(U. S.)*
Texas State J. Med.
Texas State Journal of Medicine *(U. S.)*
Textile Res. J.
Textile Research Journal *(U. S.)*
Therapia Hung.
Therapia Hungarica *(Hungary)*
Therapie Gegenwart
Therapie der Gegenwart *(Germany)*
Therap. Umschau
Therapeutische Umschau und Medizinische Bibliographie *(Switzerland)*
Ti Ch'iu Wu Li Hsueh Pao
*Ti Ch'iu Wu Li Hsueh Pao (Acta Geophysica Sinica) *(China)*
Tidskr. Mil. Halsovard
Tidskrift i Militar Halsovard *(Sweden)*
Tidsskr. Kjemi, Bergvesen Met.
*Tidsskrift for Kjemi, Bergvesen og Metallurgi *(Norway)*
Tidsskr. Norske Laegeforen.
Tidsskrift for den Norske Laegeforening *(Norway)*
Tijdschr. Sociale Geneesk.
Tijdschrift voor Sociale Geneeskunde *(Netherlands)*
Tobacco
Tobacco (includes a special section, Tobacco Science) *(U. S.)*
Tobacco Sci.
Tobacco Science (published as a special section in Tobacco) *(U. S.)*
Tohoku Igaku Zasshi
Tohoku Igaku Zasshi (Tohoku Medical Journal) *(Japan)*
Tohoku J. Exptl. Med.
Tohoku Journal of Experimental Medicine, The *(Japan)*
Tohoku Med. J.
Tohoku Medical Journal
see ***Tohoku Igaku Zasshi***
Tokushima J. Exptl. Med.
*Tokushima Journal of Experimental Medicine, The *(Japan)*
Tokyo Daigaku Koku Kenkyusho Shuho
Tokyo Daigaku Koku Kenkyusho Shusho (Bulletin of the Aeronautical Research Institute, University of Tokyo) *(Japan)*
Tokyo Kogyo Shikensho Hokoku
*Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*
Tonind. Ztg. Keram. Rundschau
Tonindustrie-Zeitung und Keramische Rundschau *(Germany)*
Torax
*Torax *(Uruguay)*
Toshiba Rebyu
Toshiba Rebyu (Toshiba Review) *(Japan)*
Toshiba Rev.
Toshiba Review
see ***Toshiba Rebyu***
Toshiba Rev., Intern. Ed.
*Toshiba Review, International Edition *(Japan)*
Toxicol. App. Pharmacol.
Toxicology and Applied Pharmacology *(U. S.)*
Trans. AIME, Met. Soc.
Transactions of AIME, Metallurgical Society
see ***Trans. Met. Soc. AIME***

Trans. Am. Clin. Climatol. Assoc.
Transactions of the American Clinical and Climatological Association *(U. S.)*
Trans. Am. Foundrymen's Soc.
Transactions of the American Foundrymen's Society *(U. S.)*
Trans. Am. Geophys. Union
*Transactions of the American Geophysical Union *(U. S.)*
Trans. Am. Nucl. Soc.
*Transactions of the American Nuclear Society *(U. S.)*
Trans. ASME (Am. Soc. Mech. Engrs.), Ser. A: J. Eng. Power
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
see ***J. Eng. Power***
Trans. ASME (Am. Soc. Mech. Engrs.), Ser. C: J. Heat Transfer
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal of Heat Transfer
see ***J. Heat Transfer***
Trans. ASME (Am. Soc. Mech. Engrs.), Ser. D: J. Basic Eng.
Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
see ***J. Basic Eng.***
Trans. ASME (Am. Soc. Mech. Engrs.), Ser. E: J. Appl. Mech.
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
see ***J. Appl. Mech.***
Trans. Bose Res. Inst. (Calcutta)
*Transactions of the Bose Research Institute (Calcutta) *(India)*
Trans. Brit. Ceram. Soc.
*Transactions of the British Ceramic Society incorporating British Ceramic Abstracts *(England)*
Trans. Can. Inst. Mining Met.
*Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia *(Canada)*
Trans. Chalmers Univ. Technol., Gothenburg
*Transactions of Chalmers University of Technology, Gothenburg, Sweden *(Sweden)*
Trans. Eng. Inst. Can.
*Transactions of the Engineering Institute of Canada *(Canada)*
Trans. Faraday Soc.
*Transactions of the Faraday Society *(England)*
Trans. Indian Inst. Metals
Transactions of the Indian Institute of Metals *(India)*
Trans. Inst. Chem. Engrs. (London)
Transactions of the Institution of Chemical Engineers (London) *(England)*
Trans. Inst. Mining Met.
Transactions of the Institution of Mining and Metallurgy (published with the Bulletin of the Institution of Mining and Metallurgy *(England)*
Trans. Japan Inst. Metals
*Transactions of the Japan Institute of Metals (Sendai) *(Japan)*
Trans. Japan Soc. Mech. Engrs.
Transactions of the Japan Society of Mechanical Engineers
see ***Nippon Kikai Gakkai Rombunshu***
Trans. Met. Soc. AIME
*Transactions of the Metallurgical Society of AIME (American Institute of Mining, Metallurgical, and Petroleum Engineers) *(U. S.)*
Trans. Natl. Res. Inst. Metals (Tokyo)
Transactions of National Research Institute for Metals (Tokyo) *(Japan)*
Trans. N. Y. Acad. Sci.
*Transactions of the New York Academy of Sciences *(U. S.)*
Transplantation
*Transplantation (formerly Transplantation Bulletin) *(U. S.)*
Trans. Roy. Soc. Can.
*Transactions of the Royal Society of Canada *(Canada)*
Trend Eng. Univ. Wash.
*Trend in Engineering at the University of Washington *(U. S.)*
Tr. Energ. Inst., Akad. Nauk Azerb. SSR
*Trudy Energeticheskogo Instituta imeni I. G. Es'mana, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*
Tr. Fiz. Inst., Akad. Nauk SSSR
*Trudy Fizicheskogo Institute imeni P. N. Lebedeva, Akademiya Nauk SSSR *(U.S.S.R.)*
Tr. Gl. Geofiz. Observ.
Trudy Glavnoi Geofizicheskoi Observatorii imeni A. I. Voeikova *(U.S.S.R.)*
Tr., Gos. Inst. Prikl. Khim.
Trudy, Gosudarstvennyi Institut Prikladnoi Khimii *(U.S.S.R.)*

Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Uralsk. Filial
Trudy Instituta Elektrokhimii, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Azerb. SSR
*Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Gruz. SSR
*Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Latv. SSR
*Trudy Instituta Fiziki, Akademiya Nauk Latvilskoi SSR *(Latvian S.S.R.)*

Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR
*Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

Tr. Inst. Fiziol., Akad. Nauk Gruz. SSR
Trudy Instituta Fiziologii, Akademiya Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Geol. Nauk, Akad. Nauk Kaz. SSR
*Trudy Instituta Geologicheskikh Nauk, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR
Trudy Instituta Metallurgii imeni A. A. Baikova, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Yadern. Fiz., Akad. Nauk Kaz. SSR
*Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Kazakhsk. Nauchn.-Issled. Inst. Mineral'n. Syr'ya
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Mineral'nogo Syr'ya *(Kazakh S.S.R.)*

Tr. Kishinevsk. Gos. Med. Inst.
Trudy Kishinevskogo Gosudarstvennogo Meditsinskogo Instituta *(U.S.S.R.)*

Tr. Komis. po Analit. Khim., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim.
Trudy Komissii po Analiticheskoi Khimii, Akademiya Nauk SSSR, Institut Geokhimii i Analiticheskoi Khimii imeni V. I. Vernadskogo *(U.S.S.R.)*

Tr., Kuibyshevsk. Aviats. Inst.
Trudy, Kuibyshevskii Aviatsionnyi Institut *(U.S.S.R.)*

Tr. Lab. Geol. Dokembriya, Akad. Nauk SSSR
Trudy Laboratorii Geologii Dokembriya, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Leningr. Politekhn. Inst.
Trudy Leningradskogo Politekhnicheskogo Instituta imeni M. I. Kalinina *(U.S.S.R.)*

Tr. Mat. Inst., Akad. Nauk SSSR
*Trudy Matematicheskogo Instituta imeni V. A. Steklova, Akademiya Nauk SSSR *(U.S.S.R.)*

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Uch. Zap., Kuibyshevsk. Gos. Ped. Inst.
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